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DRAFT ENVIRONMENTAL IMPACT REPORT

Use of Deicing Salt on California State Highways

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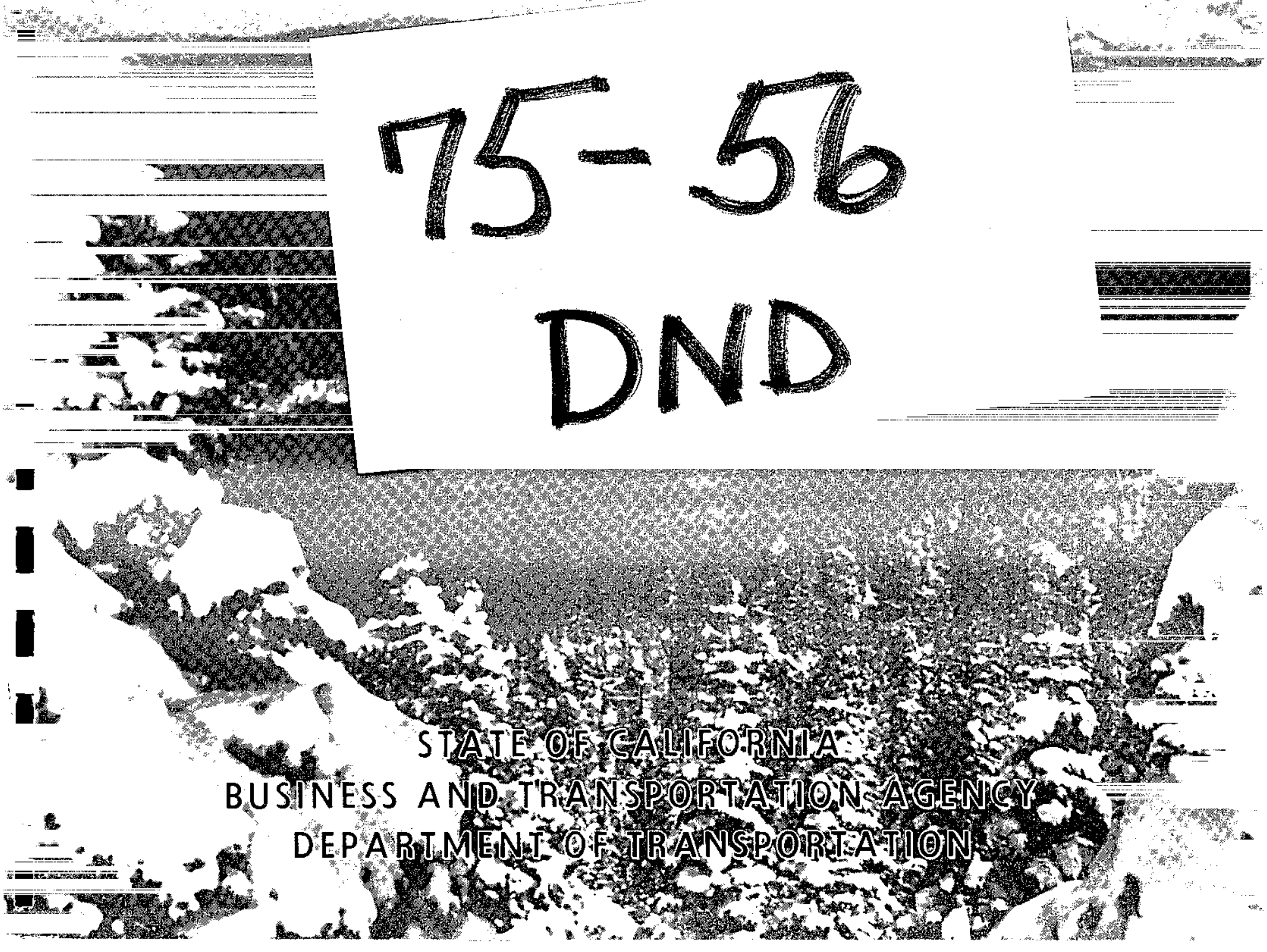

STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION

Use of Deicing Salt on California State Highways

ADMINISTRATIVE ACTION

DRAFT

ENVIRONMENTAL IMPACT REPORT

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF TRANSPORTATION

Submitted Pursuant to:

Division 13 Public Resources Code

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5-5-75
Date

available from Dist. 3

TABLE OF CONTENTS

FOREWORD

This Environmental Impact Report addresses the impacts and consequences of using or not using salt on the California State Highway System to facilitate snow removal and deicing operations. Whether or not to keep certain roads open during the snow season is not the issue here.

Potentially there may be significant effects on water quality, on vegetation along affected highways, and on the aesthetic appearance of these highway corridors caused by the use of salt.

Two in-depth studies under contract by Caltrans have been under way since 1973 to provide information on the effects of deicing salt on soil, contribution of salt to vegetation damage and soil erosion, and effects on water quality.

The plant damage study is a joint effort between the University of California at Davis, Department of Environmental Horticulture, headed by Dr. A. T. Leiser and Caltrans. The aquatic environmental study is being performed by Dr. C. Goldman of Ecological Research Associates of Davis, California.

Salt use on highways is known to cause deterioration of structures (bridges), which is a costly effect; and also some corrosion damage to vehicles, which in California is minimal.

This report presents first a summary of how and where salt is proposed to be used in California, the impact of such use, and possible alternatives. The second part of the report is an environmental study on the effects of the use of salt in the Lake Tahoe Basin, together with information and interim findings of the two research contracts which are under way.

The Lake Tahoe Basin Study is important because it is representative of one of the major geographical zones which may be harmed by excessive salt, and it is representative of the type of conditions where most of the salt used in the past in California has been applied.

SUMMARY

A. Administrative Action

(X) Draft ( ) Final

(X) Environmental Impact Report

B. Description of Proposed Action

Caltrans proposes to use salt on portions of the California State Highway System, mainly in the mountainous areas of the State and to a lesser degree in foothill, valley and desert areas, in amounts needed to facilitate snow removal and deicing.

The proposed action would be similar to present procedures used to maintain highways in a condition that is safe for the passage of traffic. Normally, a mixture of sand or cinders with a salt content of 15 to 30% is spread on the highway in areas where potential icing problems exist at the beginning of a storm in order to prevent snow from sticking to the pavement. The mixture is also spread at times when ice or packed snow causes unsafe driving conditions. In both cases, the salt lowers the freezing temperature of the snow or ice and facilitates removal.

C. Environmental Impacts

The major potential impacts of this action are:

Adverse - The possibility of damage to roadside vegetation and the resultant aesthetic effect, and the possibility of damage to aquatic life and water quality in affected water courses.

Beneficial - The proposed action is the most economical and effective method presently known to maintain highways in a safe condition during the winter season, and very likely may emerge as the least environmentally damaging of presently available options.

D. Alternatives

The following alternatives are under consideration:

1. Use salt only at specific locations for safety, such as intersections, curves, shaded areas, and steep grades.

2. Select portions of certain routes where potential vegetation damage has a greater impact due to aesthetic effect and omit use of salt in those areas.

3. Use other acceptable deicing chemicals.

4. "Do Nothing" which would mean not using salt on the highway system but continue snow removal operations and use abrasives (sand or cinders) in greater quantities to maintain safe travel.

E. Impact of the Alternatives

1. Alternative No. 1 would decrease present levels of safety and increase the use of abrasives, and increase the cost of operating equipment and vehicles. Benefits would be a reduced likelihood of impairment to roadside vegetation or water quality caused by salt.

2. Alternative No. 2 would have similar impacts as Alternative No. 1; however, on a smaller scale.

3. The impacts of the third alternative cannot be determined without first finding an acceptable substitute. Research is ongoing in this area to find an acceptable and competitive substitute for salt. Many have been tested but so far, none have been found. Many salt substitutes would have a more adverse effect on the environment than salt because of the nutrient or toxic property of the compound.

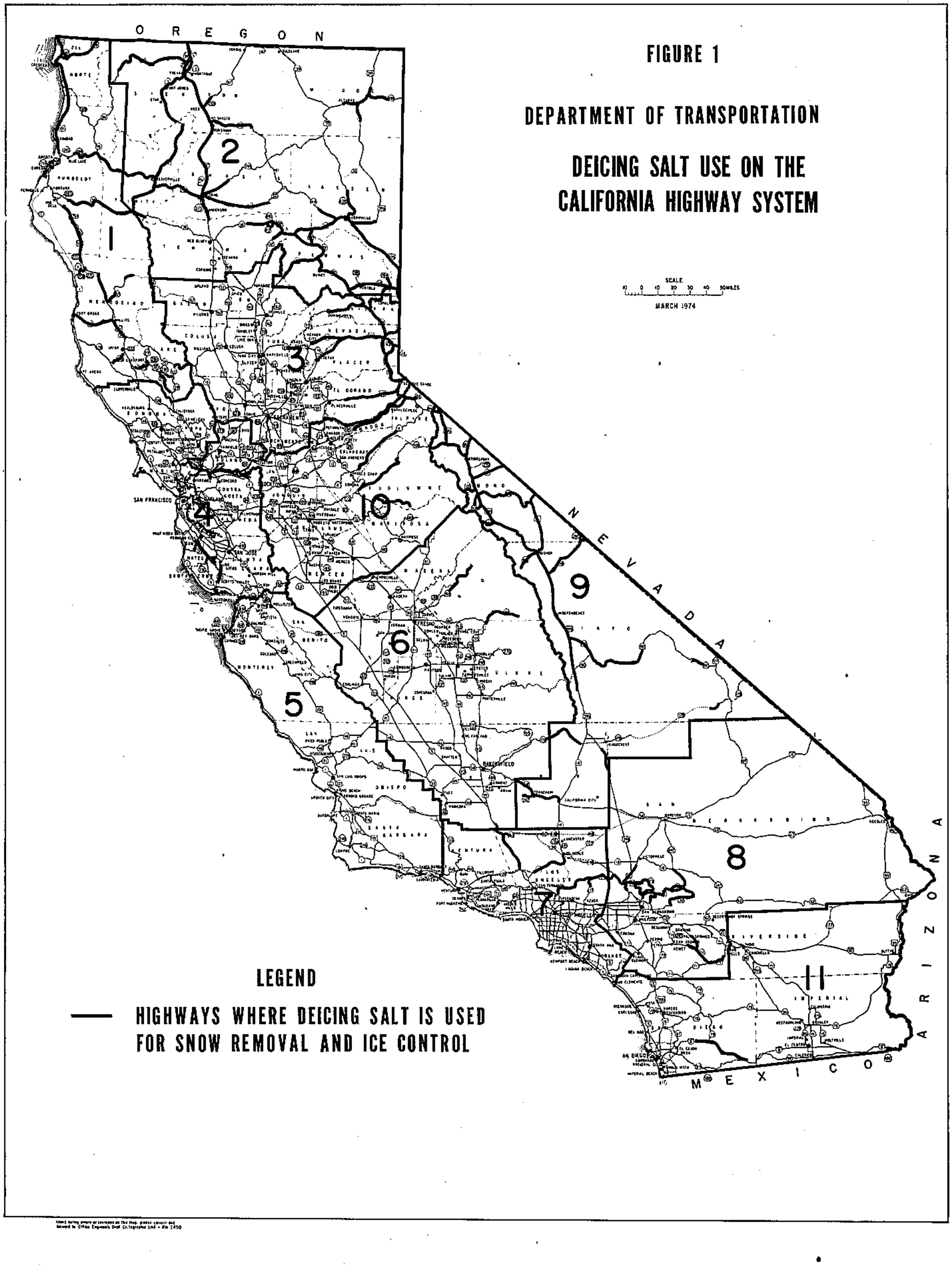
4. Alternative No. 4 would have the greatest adverse impact on traffic. It would result in longer periods of road closures, increased length and time necessitating chain controls, increased inconvenience and accidents, increased fuel consumption, added costs for abrasives and highway operation, and an economic decrease for affected businesses and industries. Benefits would be no possible impairment to soil, vegetation or water quality due to salt caused by Caltrans' highway operation.

Additional use of abrasives would have an impact as the depletion of a nonrenewable resource and the possibility of causing added sediment input to streams and lakes as well as increasing dust pollution during dry seasons.

FIGURE 1

DEPARTMENT OF TRANSPORTATION

DEICING SALT USE ON THE CALIFORNIA HIGHWAY SYSTEM



I. DESCRIPTION OF PROPOSED ACTION

Caltrans proposes to use salt to facilitate snow removal and deicing operations on portions of the State Highway System as shown on Figure 1.

The proposed action would be similar to present procedures. Normally, a mixture of sand or cinders with a salt content of 15 to 30% is spread on the roadway at the beginning of a storm in order to prevent the snow from sticking to the pavement. This initial application forms a brine which acts as a bond breaker allowing mechanical removal of the snowpack to bare pavement. The mixture is also spread at times when ice or packed snow is on the pavement. In both cases, the salt lowers the freezing temperature of the snow or ice and facilitates its removal.

Total annual use of salt on the State Highway System during the past five years has ranged from about 18,000 tons to about 27,000 tons depending on the severity of the winter season.

Over 95 percent of the total tonnage has been used on highways located in mountainous areas of the State and mainly above the 5,000 foot elevation. Figure 1 shows the routes where deicing salt is presently used. Figure 2 shows mean annual total snowfall. The boundaries and Transportation District numbers are shown in black on these figures.

Approximately half of the total annual tonnage used in California has been applied to State Route 50 and I-80 in District 3 traversing the Sierra Nevada mountain range. Other major routes where salt is used are: I-5 through the Klamath-Siskiyou Mountains, north of Redding in District 2; I-5 through the San Gabriel Mountains and the Tehachapi Mountains, north of Los Angeles in District 7; State Route 395 along the east side of the Sierra Nevada mountains, north of Bishop in District 9; and I-8 through the Laguna Mountains, east of San Diego in District 11.

Typical annual application rates range from a high of 15-25 tons of salt per lane mile on State Route 50 over Echo Summit, to 7-12 tons per lane mile on I-80 over Donner Summit, to 3-5 tons per lane mile on I-5 around Mt. Shasta and 1.5 to 3 tons per lane mile on State Route 89 in the Lake Tahoe Basin.

The objective of the proposed action is to provide an optimum and safe level of highway service through the fall and winter season commensurate with environmental concerns and economic and social needs of the public.

$\frac{208}{12} =$

16
15
225

FIGURE 2

DEPARTMENT OF TRANSPORTATION

MEAN ANNUAL TOTAL SNOWFALL (INCHES)

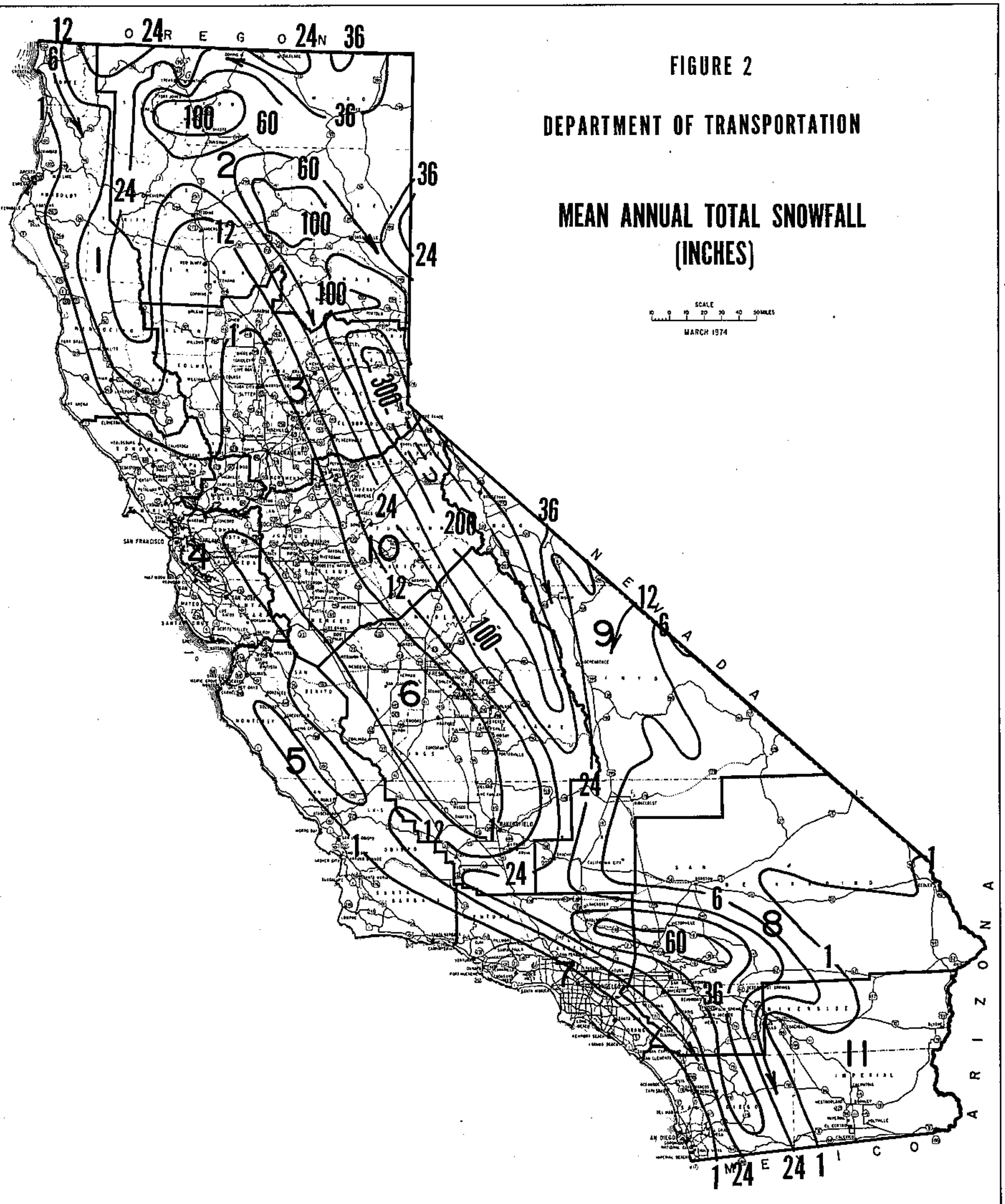
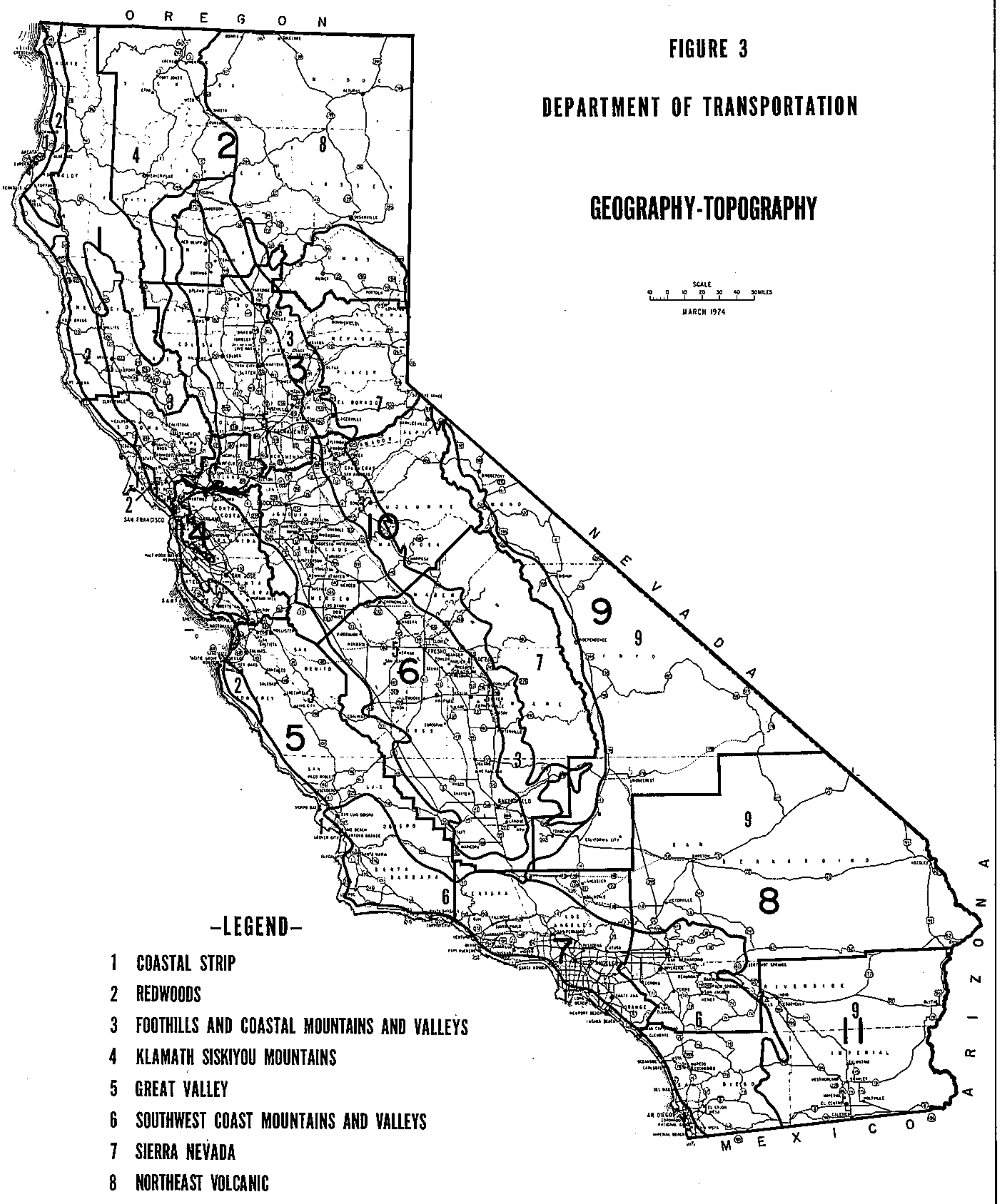


FIGURE 3

DEPARTMENT OF TRANSPORTATION

GEOGRAPHY-TOPOGRAPHY



-LEGEND-

1 COASTAL STRIP
2 REDWOODS
3 FOOTHILLS AND COASTAL MOUNTAINS AND VALLEYS
4 KLAMATH SISKIYOU MOUNTAINS
5 GREAT VALLEY
6 SOUTHWEST COAST MOUNTAINS AND VALLEYS
7 SIERRA NEVADA
8 NORTHEAST VOLCANIC
9 DESERT AND DESERT MOUNTAINS

II. ENVIRONMENTAL SETTING

The proposed action involves areas of the State influenced by the State highways shown on Figure 1. In order to relate potential impacts to specific location, California has been subdivided into general zones based on geographical characteristics. These zones are shown in red on Figure 3. In addition, the zones have been further separated into plant communities based on the system used by Munz (1970).

Highway corridors within each plant community constitute disturbed environments and plant species found directly adjacent to these highways may not be those which normally characterize the particular community. Although it is impossible to name each plant species likely to be affected and list its tolerance limits for sodium chloride, an attempt has been made to list typical plant species within each community and thereby focus attention on the natural features most likely to be affected.

The nine geographical zones shown in red on Figure 3 and their dominant plant communities which may be affected by the proposed action are listed and described as follows:

1. Coastal Strip Zone

   This area is comprised of a narrow band stretching from San Diego County northward to the Oregon border. This region is characterized by a moist, cool climate with snowfall limited to the northern extension. Plant community subdivisions of this region are as follows:

   a. Coastal Strand Plant Community

      This vegetation type is characterized by the occurrence of species such as sagebrush (*Artemisia pycnocephala*), brush lupine (*Lupinus* spp.), sand verbena (*Abromia* spp.), bluegrass (*Poa* spp.) and ice plant (*Mesembryanthemum* spp.).

   b. Northern Coastal Scrub Plant Community

      This vegetation type is characterized by species such as sagebrush (*Artemisia suksdorfi*), lupine (*Lupinus variicolor*), and coyote brush (*Baccharis pilularis*).

   c. Coastal Sage Scrub

      This vegetation type is characterized by California sagebrush (*Artemisia californica*), white sage (*Salvia apiana*), coast live oak (*Quercus agrifolia*), lemonadeberry (*Rhus integrifilia*) and California buckwheat (*Eriogonum fasciculatum*).

2. Redwood Forest Zone

   This area extends from near sea level in the north to about 3,000 feet elevation and has a constantly moist, cool climate. The area is generally covered with dense forest composed of numerous species. Plant communities found in the region are as follows:

a. Redwood Forest

This vegetation type is characterized by the dominant tree-species, Redwood (*Sequoia sempervirens*). Other common species include tanbark oak (*Lithocarpus densiflora*), Douglas fir (*Pseudotsuga menziesii*), California rhododendron (*Rhododendron californicum*) and western sword-fern (*Polystichum munitum*)

b. North Coastal Coniferous Forest

This vegetation type is characterized by species such as western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), sitka spruce (*Picea sitchensis*), grand fir (*Abies grandis*) and vine maple (*Acer circinatum*).

c. Closed - Cone Pine Forest

This vegetation type is characterized by species such as Monterey pine (*Pinus radiata*), Santa Cruz pine (*P. remorata*), Monterey cypress (*Cupressus macrocarpa*) and Mendocino cypress (*C. pygmaea*).

3. Foothills and Coastal Mountains Zone

This region is rather extensive in California as it forms a wide band along the coast ranges from Mendocino County in the north to Ventura County in the south. In addition, a transition zone between the Great Valley and the Sierra Nevadas is formed by this region as a well defined band from Shasta County southward to Kern County. The region typically has hot, dry summers and cool to cold winters. The vegetative complex is commonly referred to as chaparral where dense stands of brush occur. Plant communities found in the region are as follows:

a. Northern Oak Woodland

The vegetation type is characterized by California buckeye (*Aesculus californica*), Black oak (*Quercus kelloggii*), common manzanita (*Arctostaphylos manzanita*) and big leaf maple (*Acer macrophyllum*).

b. Southern Oak Woodland

This vegetation type is characterized by Englemann oak (*Quercus engelmannii*), live oak (*Q. agrifolia*), California walnut (*Juglans californica*) and lemonadeberry (*Rhus integrifolia*).

c. Foothill Woodland

This vegetation type is characterized by buckbrush (Ceanothus cuneatus), blue oak (Quercus douglasii), white oak (Q. lobata), Digger pine (Pinus sabiniana), California buckeye (Aesculus californica), California laurel (Umbellularia californica)and California Yerba Santa (Eriodictyon californicum).

d. Chaparral

This vegetation type is characterized by chamise (Adenostoma fasciculatum), chaparral pea (Pickeringia montana), western mountain mahogany (Cercocarpus betuloides), manzanita (Arctostaphylos spp.), scrub oak (Quercus dumosa) and redberry (Rhammus crocea).

4. Klamath - Siskiyou Mountains Zone

The area extends southward from the Oregon border to Lake County and includes the western portions of Shasta and Siskiyou Counties. The rainfall in this primarily forested area ranges from 30-85 inches annually. Major plant communities of the region are as follows:

a. Mixed Evergreen Forest

This vegetation type is characterized by Douglas fir (Pseudotsuga menziesii), madrone (Arbutus menziesii), giant chinquapin (Castanopsis chrysophylla), California laurel (Umbrellutaria California) and California black oak (Quercus kelloggii)

b. Douglas Fir Forest

This vegetation type is characterized by tanoak (Lithocarpus densiflorus), madrone (Arbutus menziesii), sugar pine (Pinus lambertiana) and Douglas fir (Psuedotsuga menziesii)

c. Red Fir Forest

This vegetation type is characterized by mountain whitethorn (Ceanothus cordulatus), lodgepole pine (Pinus murrayana), western white pine (P. monticola), Jeffrey pine (P. jeffreyi) and red fir (Abies magnifica)

5. Great Valley Zone

This area includes the Sacramento and San Joaquin Valleys. The majority of this region is developed for a wide variety of agricultural and urban uses. Since no highway salting is proposed in this region due to the occurrence of light, infrequent snowfall, further discussion of the area is limited.

6. Southwest Coast Mountain and Valley Zone

This area extends from San Luis Obispo County southward including the Transverse Ranges, the Peninsular Range and the Los Angeles Lowland. In general, the area has hot dry summers and cool winters with relatively little rainfall. Major plant communities of the region are as follows:

a. Southern Oak Woodland

(See description under 3)

b. Chaparral

(See description under 3)

c. Foothill Woodland

(See description under 3)

d. Coastal Prairie

This vegetation type is characterized by grasses and forbs of the genera Festuca, Lupinus, Ranunculus, Iris, Brodiaea, Holcus, Danthonia and Chrysopsis.

7. Sierra Nevada Zone

This area extends from Plumas County in the north to Kern County in the south along the Sierra Nevada Mountain Range. The wide elevational range and the great latitudinal range of the area produce a diversity of climatic and vegetational zones. Snow is heavy at the higher elevations throughout this zone. Major plant communities are as follows:

a. Alpine Fell Fields

This vegetation type is characterized by alpine fescue (Festuca brachyphylla), mountain sorrel (Oxyria digyna), Lemon draba (Draba lemonii), podistera (Podistera nevadensis), penstemon (Penstemon davidsonii) and alpine spring rattleweed (Astragalus tegetarius).

b. Subalpine Forest

This vegetation type is characterized by alpine willow (Salix petrophila), Quaking aspen (Populus tremuloides), Sierran penstomon (Penstemon heterodoxus), whitebark pine (Pinus albicanlis), Jeffrey pine (P. jeffreyi), lodgepole pine (P. murrayana), wax currant (Ribes cereum) and mountain hemlock (Tsuga mertensiana).

c. Yellow Pine Forest

This vegetation type is characterized by ponderosa pine (Pinus ponderosa), sugar pine (P. lambertiana), white fir (Abies concolor), manzanita (Arctostaphylos spp), incense cedar (Libocedrus decurrens) and deerbrush (Ceanothus spp.).

d. Foothill Woodland

(See description under 3)

e. Chaparral

(See description under 3)

8. Northeast Volcanic Zone

This area is dominated by the Cascades and the Modoc Plateau. Elevation ranges from over 14,000 feet at Mount Shasta to 4,000 feet on the Plateau. Annual snowfall is heavy at the higher elevations. The major plant communities of this zone are as follows:

a. Northern Juniper Woodland

This vegetation type is characterized by western juniper (Juniperus occidentalis), bitterbrush (Purshia tridentata), big sagebrush (Artemisia tridentata), Jeffrey pine (Pinus Jeffreyi) and pinyon pine (P. monophylla).

b. Yellow Pine Forest

(See description under 7)

c. Alpine Fell Fields

(See description under 7)

9. Desert and Desert Mountain Zone

This area extends from northern Mono County southward to the Mexican border and includes the Colorado and Mojave Deserts. Elevation range of the region extends from below sea level to approximately 5,000 feet. The annual precipitation averages less than six inches. Snowfall commonly occurs at the higher elevations. Major plant communities of this zone are as follows:

a. Sagebrush Scrub

This vegetation type is characterized by big sagebrush (Artemisia tridentata), saltbrush (Atriplex spp.), rabbit brush (Chrysothamnus spp.), bitterbrush (Purshia tridentata) and winter fat (Eurotia lanata)

b. Creosote Bush Scrub

This vegetation type is characterized by creosote bush (Larrea Divaricata), mesquite (Prosopis juliflora), smoke tree (Dalea spinosa) cactus (Opuntia spp.) and desert willow (Chilopsis linearis).

c. Alkali Sink

This vegetation type is characterized by saltbush (Atriplex spp.), greasewood (Sarcobatus vermiculatus), pickleweed (Salicornia virginica) and iodine bush (Allenrolfea occidentalis).

d. Pinyon-Juniper Woodland

This vegetation type is characterized by yucca (Yucca spp.), curlleaf mountain mahogany (Cercocarpus ledifolius), western juniper (Juniperus occidentalis) and pinyon pine (Pinus monophylla).

e. Joshua Tree Woodland

This vegetation type is characterized by California juniper (Juniperus californica), Joshua tree (Yucca brevifolia), boxthorn (Lycium spp.) and California buckwheat (Eriogonum fasciculatum).

There is no known direct impact on wildlife resulting from the use of deicing salt in California; therefore, no description of wildlife species which inhabit areas adjacent to State highways is necessary. There is the potential of indirect impact as particular plants which are important forage or cover components of habitat may be affected where these plants occur immediately adjacent to the highway.

III. ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

The use of salt for deicing purposes could have a potential adverse impact on vegetation and soil in close proximity to the highway, upon the quality of surface and ground waters, and upon the aesthetic appearances of these highway corridors.

The U. S. Forest Service in September 1974 published a report entitled "Conifer Damage and Death Associated with the Use of Deicing Salt in the Lake Tahoe Basin of California and Nevada". The authors of this report estimated that 3,000 conifers were dead, dying, or damaged at more than 300 sites in the Lake Tahoe Basin. This represents about 4% of the total tree population, 6 feet or taller within 60 feet of the highway, along those routes. Concentration of sodium and chloride ions was found to be several times greater in trees near the highway than in trees growing a distance away from the highways.

The U. S. Forest Service has also indicated that damage similar to that found in the Lake Tahoe Basin, but less extensive, has been observed near Mammoth Lakes and in Walker Canyon in Mono County. The application of salt on State highways has in the past been and would in the future be primarily in zones 4, 6, 7, 8, and 9 as shown on Figures 1 and 3. Of these zones, zone 7 has been, and would be the major recipient. The alleged vegetation damage described above is confined to zones 7 and 9. Vegetation damage observed in zone 6, in the mountains around San Bernardino, is believed to be caused by ozone.

Grasses are generally more resistant towards salt injury than trees, and of the trees, conifers are reportedly more sensitive than decidious trees.

Numerous streams, rivers and bodies of water are located along or adjacent to State highways throughout the described 9 zones. Concern over the possible effects to water quality caused by deicing salt motivated Caltrans to investigate this matter at potential problem locations. Tests conducted on the American River along State Route 50, the Truckee River along I-80 and State Route 89, and of Lake Tahoe along State Route 89, showed, for the rivers, a fluctuation of chloride levels corresponding to weather and salt application activity. At no time did the concentration of chloride levels approach the maximum allowable level of 250 ppm for domestic water. To date there have been no indication of adverse effects on the water quality of Lake Tahoe which could be attributed to highway salting. No adverse impact of the quality of water of large streams or lakes has been demonstrated to be caused by the use of deicing salt. The water quality of small streams, ponds and wetland areas, however, could potentially be affected by such use.

No significant vegetation damage along State highways related to the use of deicing salt is known or has been identified in any of the other 7 zones.

Since potential damage would occur in a narrow band immediately adjacent to the roadside which could alter the composition of the plant species of this plant community, adverse aesthetic impact may prove to be the most severe environmental impact if the use of salt is the cause of vegetation damage. Mitigation for affected areas would be to remove affected vegetation or to re-vegetate such areas with more salt tolerant vegetation native or adaptable to such areas.

Impacts to the aquatic environment are different than impacts to the terrestrial environment. The boundaries of salt influence are defined by drainage structures and stream courses. The extent of the 'watershed' of each drainage structure, amount of salt applied, and weather conditions determine the quantity of salt that enters any particular body of water.

The most direct impact is the increase in sodium and chloride ion concentrations which occurs at the outflow of a highway drainage structure. This localized impact can affect the aquatic flora and fauna, particularly macroinvertebrates. These small organisms are part of the fish food source. Although sodium and chloride ion concentrations would probably not exceed lethal levels, stress could be likely. Changes in reproduction and growth would in turn affect the standing crop of fish. Further downstream the salt is diluted to an ineffectual level.

Another potential type of impact is the biostimulatory effect of trace elements in the salt. In most cases this would not be a significant impact. However, it would be significant if the trace element in salt is also the limiting factor in an aquatic ecosystem. The result would be an increase in primary productivity, or algal growth. This can lead to several other conditions known as eutrophication. This type of impact would accrue over a number of years.

Deterioration of highway structures (bridges) due to salt-caused corrosion has been of concern to Caltrans for a number of years. It is the most costly effect identified to date due to the use of salt. Protective seals have been utilized in an attempt to minimize this effect. Many bridge decks have been replaced.

Some corrosion damage to vehicles and equipment is caused by the use of salt on highways; however, this is a relatively minor impact in California.

IV. UNAVOIDABLE ADVERSE IMPACTS SHOULD THE PROPOSED ACTION BE IMPLEMENTED.

If the use of salt for deicing and snow removal purposes proves to be detrimental to soil properties and thereby damages vegetation along affected highways, then continued use would have an effect that could not be avoided.

Long-term increases of salt in the upper soil layers and in plant tissue may result in a change in species composition. This can occur through replacement by man to more salt tolerant species or by natural processes with plants having a greater adaptive advantage. Either case may alter the carrying capacity of the habitat and species composition of the wildlife. Long-term impacts to the aquatic environment may include changes in fish food resources of streams, stratification of ponds, changes in species composition of wetland areas, and increases in eutrophication rates.

Continued use of salt would result in deterioration of structures and contribute to corrosion of vehicles.

V. ALTERNATIVES

The following alternatives are under consideration:

1. Use salt only at specific locations for safety, such as intersections, curves, shaded areas, and steep grades and continue snow removal operations and use of abrasives in greater quantities at remaining locations.

   This alternative would increase the cost of operation of equipment, increase the use of abrasives such as sand and cinders, increase traveling time in the affected areas, increase fuel consumption and decrease safety.

   The increased use of abrasives would cause some additional siltation of streams and lakes as well as more roadway dust pollution.

   Benefits would be less impairment of soil properties and less likelihood of vegetation damage.

2. Select portions of certain routes where potential vegetation damage would have the greatest impact due to aesthetic effect and eliminate use of salt in such areas.

   The impacts and effects of this alternative would be similar to alternative 1, however, on a smaller scale.

3. Use other acceptable deicing chemicals in place of salt. Research is ongoing to attempt to find a deicing chemical that may take the place of salt. So far none have been found. The substitutes which have been tried are more damaging than salt, cause unsafe driving conditions in terms of skid resistance, or are economically prohibitive.

4. "Do Nothing" which would mean not using salt on the highway system, but continue snow removal operations and use of abrasives in greater quantities to maintain safe travel.

   This alternative would have the greatest impact on the traveling public. It would result in longer periods of road closures, increased inconvenience and accidents, increased fuel consumptions, added costs for abrasives and highway operation, and a minimal economic decrease for affected businesses and industries.

   Benefits would be no impairment to vegetation or water quality because of salt.

VI. CUMULATIVE AND LONG-TERM EFFECTS OF THE PROPOSED ACTION

If salt used as a deicing chemical on highways is found to cause damage to the environment the long-term effect of this proposal would mainly influence the aesthetic appearance of vegetation along affected highway stretches and secondarily could affect salt concentration in soil, soil erosion, sedimentation of watercourses and groundwater in localized areas.

The long-term impact on vegetation might include lower survival success of annuals, reduced growth of salt sensitive species, and possible elimination of salt intolerant species. This would tend to reduce the vegetative cover, expose more soil and thus could increase erosion.

Two in-depth research studies are currently under way to determine the effects of deicing salts on terrestrial vegetation and on aquatic environments. These studies are described in more detail in the following environmental study for the Lake Tahoe Basin. The results of these studies are expected to be available in 1977 and late 1975 respectively. Preliminary conclusions from the vegetation study show that damage to vegetation caused by salt most likely will fall between being insignificant at some locations to being the primary cause at others. Preliminary conclusions from the aquatic study indicate that no significant adverse effects are likely to occur to the quality of water as a result of using salt on highways.

VII. ECONOMIC AND GROWTH-INDUCING IMPACTS

The proposed action of using salt on the highway system does not induce growth or affect the State's economy to any measurable degree. Specific areas in the State which depend in part upon winter recreation activities for their overall economy are to some degree dependent upon the convenience of access to such areas. A discussion of these factors for the Lake Tahoe Basin is included in the following environmental study.

STUDY OF THE EFFECTS

OF

THE USE OF DEICING SALT

ON

CALIFORNIA STATE HIGHWAYS

IN

THE LAKE TAHOE BASIN

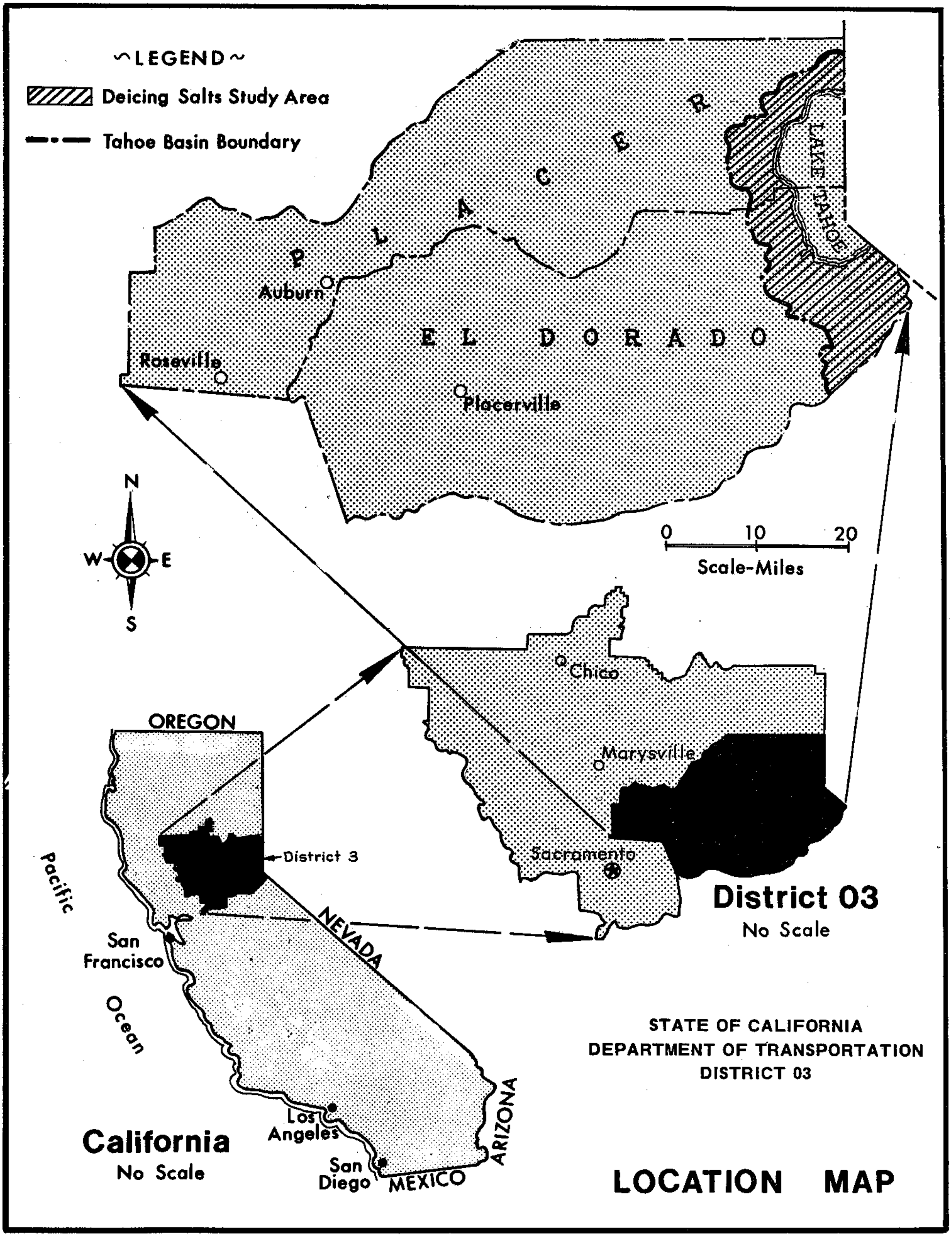
STATE OF CALIFORNIA
Business and Transportation Agency
Department of Transportation
District 03
Marysville

Foreword

This portion of the Environmental Impact Report is concerned with the use of salt for deicing California State Highways in the Lake Tahoe Basin. Figure 1 shows the relationship of the Tahoe Region to the State of California.

Reference numbers in the text refer to data obtained from those listings shown in the SOURCES Section of this report. The reference numbers in the text are not necessarily in consecutive order.

FIGURE 1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Deicing Salts Study Area
Tahoe Basin Boundary
P L A C E R
LAKE TAHOE
Auburn
Roseville
E L D O R A D O
Placerville
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Scale-Miles
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Sacramento
District 03
No Scale
OREGON
District 3
Pacific
Ocean
San Francisco
NEVADA
Los Angeles
San Diego
MEXICO
ARIZONA
California
No Scale
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DISTRICT 03
LOCATION MAP

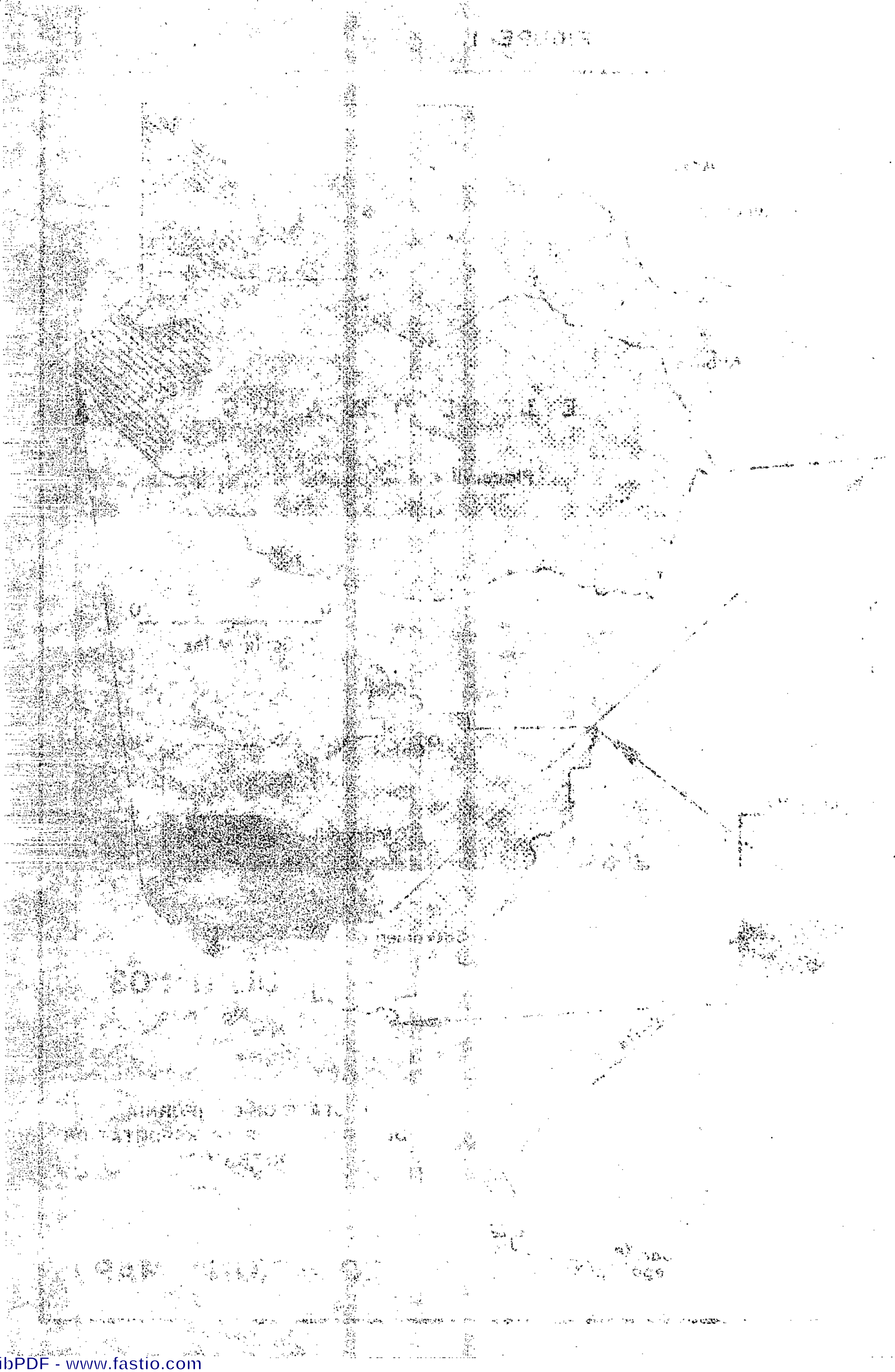


TABLE OF CONTENTS

Page

LIST OF FIGURES

ATTACHMENTS

SUMMARY

The Lake Tahoe Basin is noted for its beautiful environmental setting. The forested areas, the Lake with its characteristic deep blue color and the surrounding snowcapped mountains have attracted visitors from all over the world. Permanent and seasonal residency has increased on a steady basis and recreation facilities have flourished. Transportation facilities have been improved to facilitate access to the Basin throughout the year.

Increased traffic volumes during the winter season have either necessitated improved maintenance procedures or improved procedures have encouraged the increase in volumes. In either case, one of the tools which has helped to provide this improvement in winter access is the use of salt as a deicing compound to provide bare pavement more of the time and sooner after storms. The amount of salt used has generally increased up until 1973-1974 when there was a 50% decrease from the year before. This was partly due to seasonal variation and partly due to a concentrated effort to reduce the amount of salt used.

This study is an attempt to weigh the effects of the use of salt on the environment and in particular on vegetation in the highway corridor; on water quality; on terrestrial wildlife and aquatic habitat; and on the safety and convenience to the highway user.

A survey of vegetation damage by the U.S. Forest Service in 1973 shows higher chloride levels in trees near the highway. This study was primarily diagnostic and was undertaken to determine the cause rather than extent. Further research was deemed necessary.

The Department of Transportation (Caltrans) Laboratory in Sacramento initiated two studies in 1973. One is to study the effects of deicing salts on terrestrial vegetation and explore other possible causes of plant damage and indicate alternative courses of action. The other is a study on the influence of highway deicing salt and other deicing compounds on aquatic environments.

The studies are being financed by Federal Highway Administration and are being conducted in cooperation with Dr. A. T. Leiser at the University of California at Davis and Dr. Charles Goldman of Ecological Research Associates. Interim reports for both studies will be published in summer 1975.

Further studies and data research in regard to safety, highway user impacts and alternatives and their costs have been conducted by Caltrans.

Pertinent information from all sources is summarized as follows:

1. Average annual salt useage on 66 miles of State highways in the Tahoe Basin for the last ten years is 1,460 tons.

2. Number of trees within 60 feet of highway and 6 feet or taller, estimated by U.S. Forest Service to be damaged or dying, is 3,000. This represents about 4% of the total which could be affected in this corridor.

3. If all of the 1,460 tons of salt per year went into Lake Tahoe for the next 50 years, the average concentration would increase by 0.44 parts per million over the present level of 2.6 ppm, which is less than the allowable of 5 ppm.

4. If use of salt were discontinued it is estimated there would be a 50% increase in time of chain control, a 4% reduction in total vehicle miles traveled in the Basin by 1995; a 50% increase in use of abrasives; a net increase in annual cost of snow removal operation of $208,000 (44%).

5. Study of accidents on Highway 50 between Riverton and Meyers indicates 4 times as many accidents occur within chain control areas where snow and/or ice is on the pavement as compared to bare pavement.

6. No satisfactory substitute for salt has been found which has the needed deicing qualities and yet is environmentally acceptable.

7. Rate of application of salt during 1974 is 24 to 44 tons per highway mile on Route 50 between Kyburz and Meyers and 3.5 to 6.5 tons per highway mile on Route 89 between South Lake Tahoe and Tahoe City.

8. Salt is damaging to reinforcing steel in bridge decks and to metal parts on motor vehicles. A satisfactory substitute or acceptable alternate would be most welcome.

9. Research should certainly continue in the quest for improved methods of winter maintenance.

DESCRIPTION OF STUDY

I.

DESCRIPTION OF STUDY

A. Study

This study is for the use of salt to deice State Highways in the Lake Tahoe Basin which are under the jurisdiction of the State Department of Transportation, (Caltrans) District 03, beginning with the 1975-76 winter season.

B. Location

The location of the study area is that portion of the counties of El Dorado and Placer that lie within the Lake Tahoe Basin which generally includes that portion of the watershed within the boundaries of the State of California which drains into Lake Tahoe. (See figure 2)

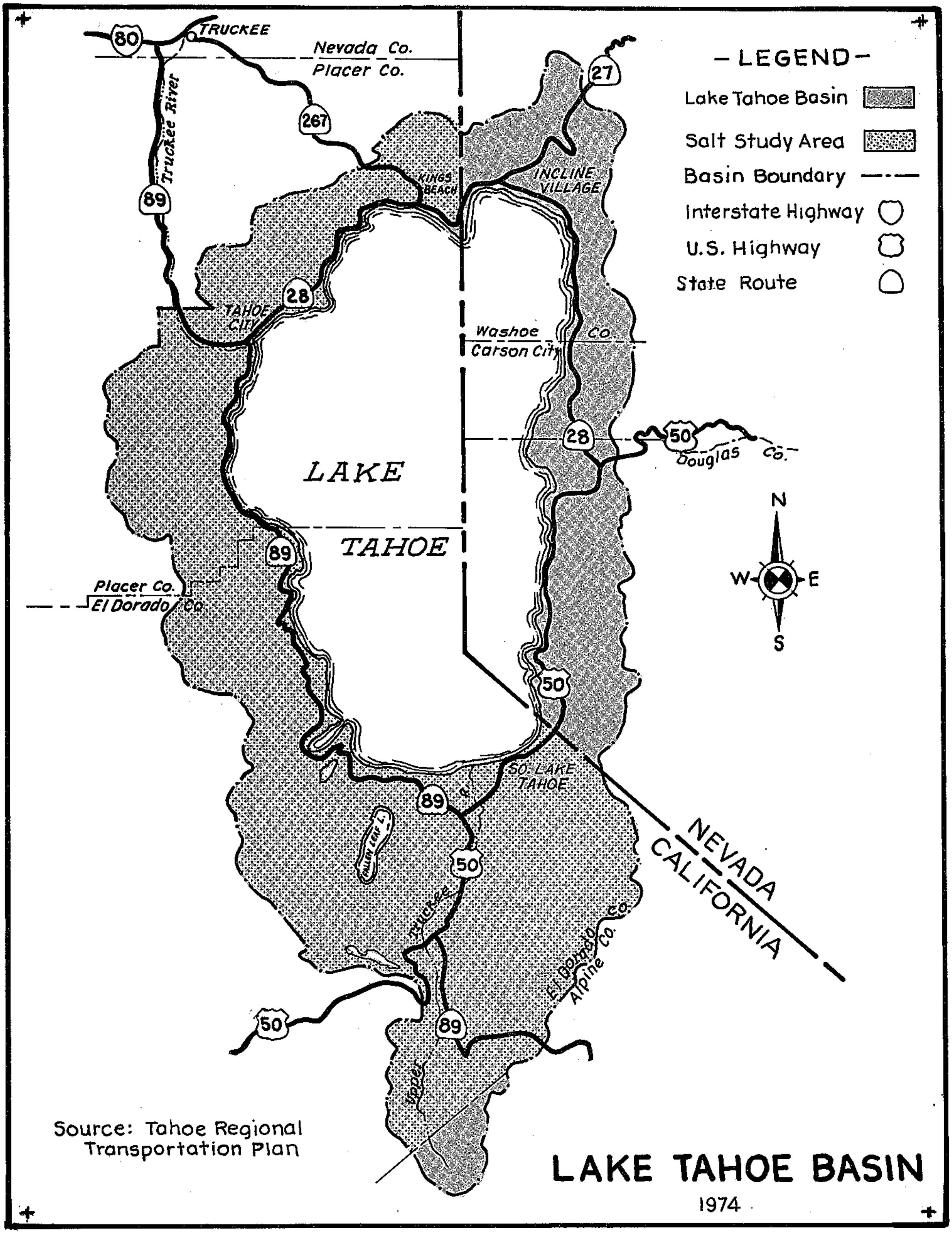
C. Purpose of the Action and Background Information

Salt has been used as an aid in deicing roads as part of snow removal operations in California since the early 1950's. The result of its use along with development of equipment and methodology now enables highway maintenance personnel to carry out an efficient bare-pavement policy during almost all of the winter season. Since the early 1950's, development of recreational facilities such as ski resorts, gaming houses and stage show attractions have resulted in a significant growth in the permanent and transient populations in the Tahoe Basin. Related industries such as motels, stores and service stations are presently supported by the combined effects of these permanent and transient populations. Winter activities now approach the income productivity which was previously experienced only in the summer season. There is for example one campground on the west shore now open and available through the winter season.

This increase in development and the need and desirability to provide better driving conditions have gone hand-in-hand. As in the case of any center of attraction, accessibility is a key factor. The issue to be evaluated now is what level of service should be sustained in view of evidence that indicates the possibility of damage to the environment of the Tahoe Basin through the use of salt for deicing roadways. The aesthetic attributes of the vegetation and the Lake and the variety of potential uses are an important part of the basic attraction to the area.

An environmental assessment of the impacts is being made on the basis that the use of salt for highway deicing is a discretionary option on the part of Caltrans.

FIGURE 2


- LEGEND -
Lake Tahoe Basin
Salt Study Area
Basin Boundary
Interstate Highway
U.S. Highway
State Route
TRUCKEE
80
Nevada Co.
Placer Co.
267
Truckee River
89
27
KINGS BEACH
INCLINE VILLAGE
28
TAHOE CITY
Washoe Co
Carson City
50
Douglas Co.
LAKE
TAHOE
N
W
E
S
Placer Co.
El Dorado Co.
SO. LAKE TAHOE
NEVADA
CALIFORNIA
Fallen Leaf L.
Truckee
El Dorado Co.
Alpine Co.
Upper
Source: Tahoe Regional Transportation Plan
LAKE TAHOE BASIN
1974

The objective of the proposed action is to provide a level of highway service commensurate with the economic, social and environmental needs of the people in consideration with the natural setting of the Tahoe Region.

Caltrans estimates that if salt were not used, the length of time for chain controls would be increased by at least 50% at all entrances to the Tahoe Basin. Based on a 50% increase, it is estimated that the travel in and out of the Basin during the November through April period would be reduced approximately 4% by 1995. The greatest impact would be on Route 50 where chain controls are in effect for longer periods of time than on other routes into the Basin. Another factor which is detrimental to the attraction of Route 50 as a winter travel route is the distance that chains have to be used when controls are in effect - a minimum of 12 miles between Twin Bridges and Meyers.

This much travel reduction would not occur during the first year of non-salt snow removal. Travelers unfamiliar with the increase in hazardous driving conditions and the greater probability of having to put chains on would continue their trips to their destination. The second and ensuing years would effect reduced travel into the Basin after travelers had been exposed to and inconvenienced by the "non-salt" road conditions.

Estimated traffic volumes for the "with salt" and "without salt" conditions are as follows:

<u>With Salt</u>

1975-76 Winter Daily Vehicle Miles Traveled = 483,000 at 30 mph Average

(November through April)

1995-96 " " " " " = 874,000 at 27 mph Average

Heavy Duty Vehicles = 4%

<u>Without Salt</u>

1975-76 Winter Daily Vehicle Miles Traveled = 473,000 at 28 mph Average

(November through April)

1995-96 " " " " " = 839,000 at 25 mph Average

Heavy Duty Vehicles = 4%

Speed differentials between the "with" and "without" salt conditions are very small because the data represents average conditions for the entire winter season. Speeds are not limited during a great percentage of the season when the pavement is clear.

The approximate average winter daily traffic volumes for the four entrances to the Basin in California are shown for comparison.

	Rte. 89 at Luther Pass	Rte. 50 at Echo Summit	Rte. 89 at Tahoe City (No)	Rte. 267 at Brockway Summit
1955	100	1000	900	*
1965	450	3100	2700	550
1974	990	5750	8500	3400

*Not in State Highway System at the time.

ENVIRONMENTAL SETTING

II.

ENVIRONMENTAL SETTING

A. General

The Tahoe Basin lies high in the Sierra Nevada Mountains on the California Nevada border. It is surrounded by mountain peaks with the floor of the basin dominated by Lake Tahoe. The lake is approximately 22 miles long by 12 miles wide and is one of the largest high-altitude lakes in the world with a surface elevation of 6,225 feet above mean sea level.[1] The Tahoe Basin consists primarily of the watershed for Lake Tahoe and is located approximately 150 miles northeast of San Francisco as shown on Figure 3. The basin is very attractive to visitors and residents due to: the scenic beauty, climate, gaming and recreational activities that are available.

B. Aesthetics

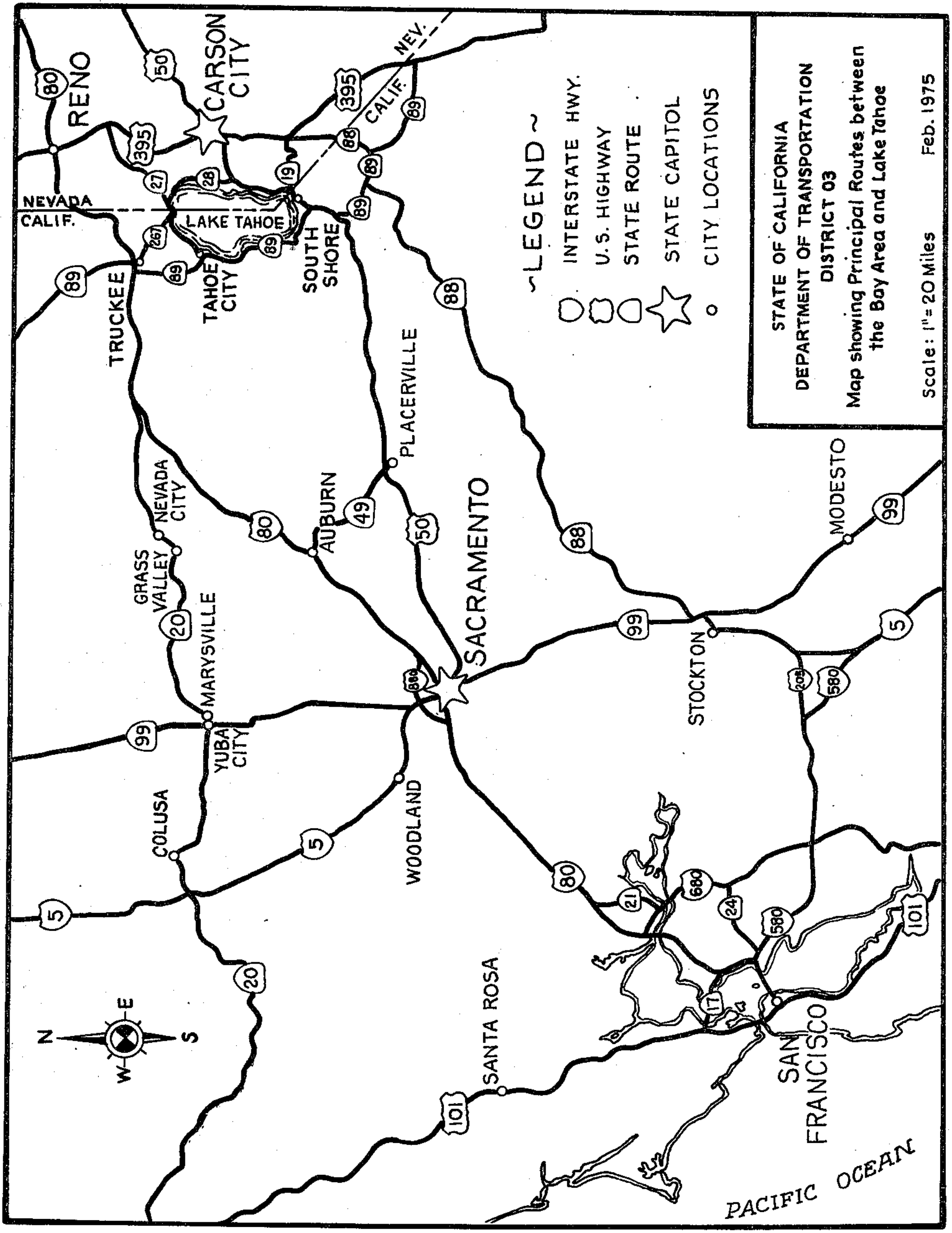
The overall Tahoe Basin is primarily an enclosed landscape. The Lake, encircled by mountains, creates a bowl-like form where the primary lines of visual attention are drawn to the Lake and secondarily to the mountains around the sides and to the water's edge.

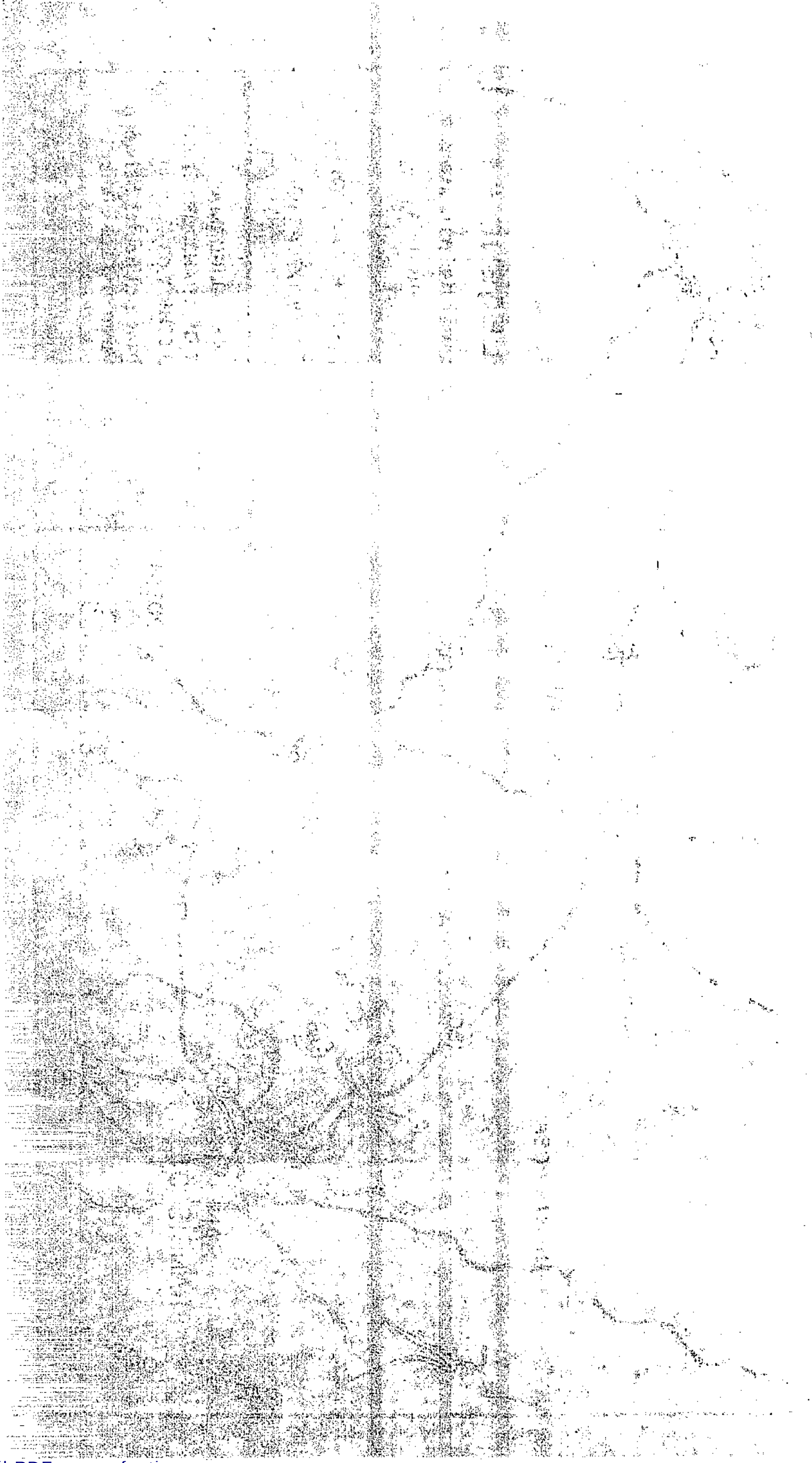
The dominant colors in the landscape are the various shades of blue, green or gray of the Lake. Secondary are the greens of the forest, the grays and blacks of weathered surface rock and the browns and grays of tree barks.

For more than 100 years, Lake Tahoe and the basin surrounding it have been recognized as one of the major national attractions. The clarity and purity of the water, the spectacular scenery of unique geological conditions and the diverse vegetation in the Basin combine to present a setting that the famous author and outdoorsman Mark Twain described as "The fairest view the whole earth affords."[1]

In contrast to the natural beauty of the Basin there are areas of development along major routes that do not differ significantly from commercial strip development in any other urban area. The most pronounced example is South Lake Tahoe. Along the four-lane section between Mays junction of Routes 89 and 50 and the Nevada State Line there are numerous businesses mainly motels, service stations, retail outlets and eating establishments. The few trees that exist on this section and the one short segment where the Lake can be seen are secondary to the effect of urban influence.

FIGURE 3


STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DISTRICT 03
Map showing Principal Routes between the Bay Area and Lake Tahoe
Scale: 1" = 20 Miles
Feb. 1975
~LEGEND~
INTERSTATE HWY.
U.S. HIGHWAY
STATE ROUTE
STATE CAPITOL
CITY LOCATIONS
RENO
CARSON CITY
NEV.
CALIF.
NEVADA
CALIF.
LAKE TAHOE
TAHOE CITY
SOUTH SHORE
TRUCKEE
PLACERVILLE
AUBURN
NEVADA CITY
GRASS VALLEY
MARYSVILLE
YUBA CITY
COLUSA
WOODLAND
SACRAMENTO
STOCKTON
MODESTO
SANTA ROSA
SAN FRANCISCO
PACIFIC OCEAN
N
E
S
W



C. Topography and Geology

1. General

The Tahoe Basin, which has a perimeter of almost 140 miles, is the exclusive watershed for Lake Tahoe. More than 100 miles of the basin boundary is higher than 8,000 feet above sea level, and almost 40 miles is higher than 9,000.

Paved highways enter the basin at seven locations. In Nevada there are three: Tahoe Meadows (the highest in elevation at 8,570 feet), Spooners Summit (elevation 7,140), and Daggett Pass (elevation 7,334). In California there are four: Luther Pass (elevation 7,740), Echo Summit (elevation 7,382), Tahoe City (the lowest, at 6,230 feet) and Brockway Summit (elevation 7,199).

The Tahoe Basin is generally considered to be within the Sierra-Nevada geomorphic province and has been strongly influenced by the Basin and Range geomorphic province to the east. This area is a fault-formed, depressed, intermountain basin, a part of which is occupied by Lake Tahoe. In general, uplifting has occurred along a series of near-vertical northerly trending faults, some of which has been active during recent historical time.

The oldest geological units studied in the Tahoe Basin area are metamorphic sediments of Paleozoic age. These rocks are exposed mostly along the crest of the Sierra-Nevada mountains at the west edge of the basin, where they are in contact with underlying granitic rock. The metamorphic and granitic rocks were uplifted, eroded, and subsequently covered with younger volcanic lava flows during Pliocene and Pleistocene time. In more recent geological times, glacial and alluvial lake deposits have mantled portions of the Tahoe Basin.[2 & 3]

D. History and Archaeology

There are no significant impacts on either archaeological, paleontological or historical sites by the proposed action or any of the alternates.

E. Meteorology[5]

Climate of the region is strongly influenced by topography. Marine air from the Pacific Ocean, 150 miles to the west, drops its moisture (mostly as snow) as it rises over the crest of the Sierra. Average annual precipitation ranges from more than 50 inches on the western side of the region to about 25 inches along much of the eastern shoreline. The Weather Bureau at Tahoe City, on the west side, reports long-term average snowfall of 213 inches. The fairly long summers are comparatively cool; mean maximum temperature at Tahoe City in July over a 50-year period was 78°F. Winters are cold, but seldom severe; mean daily minimum temperature for January over the same period was 17°F. The high elevation and cool temperatures result in a short growing season - an average of only 70 to 120 frost-free days per year at various points near the Lake.[5]

The capacity of various parts of the Lake Tahoe Basin to assimilate or disperse the air pollutants associated with auto exhaust, incineration, and wood smoke depends partly upon wind flows and vertical air currents. Wind erosion of exposed ground is a major source of dust in the air and hence sediment that ultimately is borne to streams and the Lake.

The Precipitation Map (Attachment #1) shows the location of climatological and air pollution recording stations. In general study of the climate of the Lake Tahoe Basin, it is necessary to keep in mind not only factors influencing the basin as a whole (e.g. seasonality and regional storms), but also variations in climate between the east and west shores, and between high and low elevations.

Because of the summer-dry, winter-wet precipitation regime of the Sierra Nevada, the cold season corresponds to the wet season in the Lake Tahoe Basin, and most of the precipitation is snow. Approximately 55 to 70 percent of the average annual precipitation (rain and snowfall water content) falls during the 4-month period of December through March. At elevations below 6,500 feet, about 75 to 80 percent of this precipitation normally is snow; at elevations of 8,000 feet and higher, approximately 90 to 95 percent of winter precipitation is snow.[5]

At elevations below 6,500 feet the snow season (when a continuous snow cover is present) usually begins early in December and continues into early or mid-April. At altitudes above 8,000 feet the snow season is somewhat longer - from early November to early or mid-May. The snow cover period varies considerably from year to year. Also, the snow cover period varies within the Basin; part of the east shore occasionally has a partially "bare ground" winter.[5]

Despite the snowy winters, temperatures in the Lake Tahoe Basin are comparatively mild; daytime high temperatures during January average 35-40°F. at lowest elevations. Nighttime low temperatures vary much more because of topographic complexity; but they generally range from the low teens to low 20's. These temperatures, all mild for this elevation, can be attributed to: 1. The high amount of winter sunshine -about 50 to 60 percent of total possible hours; 2. the comparatively mild Pacific air masses that enter the area in winter; 3. the high elevation and consequently clean upper air that allows maximum insolation; 4. the "heat reservoir" characteristics of the Lake in winter (i.e., the Lake is warmer than the surrounding land because of the thermal character of the water in contrast to that of the land); and 5. the low-level (ground-based) temperature inversion that is common at night in the Tahoe Basin, which confines more extreme low temperatures to the lowest levels away from the Lake.[5]

Attachment No. 1, showing mean annual precipitation, indicates the wettest area to be in the northwest, where total precipitation, by some estimates, averages more than 70 inches. The driest portion of the Basin area is adjacent to the central east shore, where annual averages are less than 18 inches.[5]

Precipitation at Lake Tahoe varies greatly from year to year for two reasons. One is that the area is fairly far to the south of the Gulf of Alaska wintertime storm breeding area and the jet stream track. Also, more than half of the winter half-year precipitation frequently falls in 12 to 14 days, but not consecutive days, and winter precipitation can be heavy in the Basin. Complete data on precipitation in El Dorado and Nevada Counties are available from the National Weather Service and are published in their County Summaries.[5]

F. Vegetation

The Lake Tahoe Region has a variety of plant life, more than 500 species of native plants and at least 160 introduced species. Systematic study of the native vegetation in California several years ago resulted in definition and description of nearly 30 specific types of plant communities that have individual characteristics of growth and survival. Vegetation in the Tahoe region is represented in 13 of these community types. (See Attachment #2) The varied climate and highly erodible soil combine to make the Lake Tahoe region a fragile environment. Hence, the ecological balance is easily upset. Whenever vegetation is removed, it is generally not soon replaced.[56]

All wildlife in the Tahoe Basin is dependent upon the habitat which supports it. Vegetation is the critical element of most wildlife habitats. Therefore, habitat is discussed in this report as applied to vegetational communities in the study area. The 13 basic vegetation types in the Lake Tahoe Basin are keyed to areas shown on the attached vegetation types map as listed in the left column. They are described as follows:[56]

Map Key

0 Aquatic - Consists of wetlands including lakes, streams, ponds, and reservoirs. These areas are ecologically fragile.

1 Barren - Areas essentially devoid of well-developed vegetation due to natural, physical or climatic limitations. Includes areas on steep slopes and above timberline.

1a Disturbed - Areas essentially devoid of well-developed vegetation resulting from man's activities. Includes roadsides and areas of extensive human development.

2 Herbaceous - Primarily areas with low-growing grasses and forbs. Includes some areas with scattered tree or shrub overstories as well as meadows and ephemeral marshes. The distribution of this ecologically fragile habitat type is generally limited to the perimeter of aquatic areas.

4 Sagebrush - Areas of sagebrush in association with other shrub species including bitterbrush, whitethorn and scrub oak. This type is confined primarily to gentle slopes with shallow soils and southern exposures.

6 Montane chaparral - Areas of shrub species other than sagebrush and riparian shrubs generally found at elevations of 6,000 to 9,000 feet. One of the dominant types.

7 Riparian shrubs - Areas directly adjacent to water or water courses. Common plant species include willow, aspen and alder.

9 Broadleaf forest - Areas with open stands of broadleaf trees, predominantly aspen, alder and black cottonwood. Shrubs are commonly found in the understory.

14 Pine forest - Areas of pure pine stands consisting mostly of Jeffrey, ponderosa and sugar pines. One of the dominant types.

17 Mixed conifer forest - Areas of mixed pine and fir including lodgepole pine, white pine, Jeffrey pine and fir. One of the dominant types.

18 Fir forest - Areas of red and white fir present in both pure and mixed stands. One of the dominant types.

19 Lodgepole pine forest - Areas of essentially pure thickets of lodgepole pine.

20 Alpine forest - Areas of high elevation, noncommercial, timber stands consisting of juniper, hemlock, western white pine and white bark pine. These areas are generally found near timberline. These areas are ecologically fragile.

The habitat types found in the Tahoe Basin are distributed according to various physical influences such as elevation, moisture, slope exposure, soil fertility and microclimatic features common to the area. These physical features produce a mosaic of wildlife habitat types with one often blending into another. As indicated above, several of these habitat types are considered fragile in terms of the effects of human development or other physical disturbances. The relative acreage of these habitat types are constantly changing in total area due to environmental alterations.

According to the publication "Land Resources of the Lake Tahoe Region",[58] "Insects, tree disease, and fire annually deplete timber stands. Loss from these three causes is estimated at 35% of the annual growth. Losses from all natural causes approximate 5 million board feet annually in the Lake Tahoe region".[58]

Representatives of almost all plant species can be found in the variable width corridor of direct highway influence.

G. Wildlife

In general, representative species from each broad category of wildlife, except waterfowl, are found in each of the habitat types. Waterfowl are commonly found only in the aquatic and herbaceous habitat areas.

The highway corridor passes through or influences all of the wildlife habitat previously discussed. The identified wildlife in the Tahoe Basin exhibit low to medium capability to withstand mans disturbances and will react in a negative manner. Deer are known to migrate out of the Basin in winter. Other large mammals such as Black Bear and Mountain Lion are so few in number that they must be considered rare.[11]

Approximately 275 species of wildlife inhabit the Lake Tahoe Basin. The majority of the area's wildlife is distributed throughout the 13 habitat types, with the exception of 22 species of waterfowl which have restricted distributions.[11]

With regards to rare and endangered species found in the area, little information is available on the status of most populations. The southern bald eagle and the American peregrine falcon are listed as endangered by both the California Fish and Game and the U.S. Fish and Wildlife Service. The wolverine is listed as rare by the California Department of Fish and Game. The spotted bat is listed as threatened by the U.S. Fish and Wildlife Service. Several species are considered locally rare or endangered in the Tahoe Basin. They include the golden eagle, American osprey, pileated woodpecker, Anthony's green heron, Sierra red fox, fisher and pine marten.

For a few years before the turn of the century there was commercial fishing in Lake Tahoe and the fish population was greatly depleted. The nutrient supply of the lake water was too low to encourage a rapid revival. The Lake is now stocked with fish, mostly trout and Kokanee salmon from hatcheries, that provide sport fishing. Lake trout, brown trout and brook trout as well as the native cutthroat-rainbow trout and white fish are caught. Cutthroat trout, weighing as much as 35 pounds, have been taken from the Lake. There are many miles of fishable stream in the Basin, with the predominate species of fish being trout.[1]

The aquatic system of Lake Tahoe and its tributaries is complex and interrelated. It includes Lake Tahoe, the minor lakes, and all the streams in the region. The aquatic vegetation, plankton, mollusks, aquatic insects, crustaceans, and fish compose the living portion of the system. For a more complete discussion of aquatic food web and Environmental influences refer to: "Fisheries of Lake Tahoe and Its Tributary Waters", 1971.[12]

H. Water Quality

The water in Lake Tahoe is pure and exceptionally clear. All natural water contains dissolved solids, but streams flowing from mountain regions that drain granitic rock, such as makes up much of the Lake Tahoe Basin, usually carry less dissolved materials than do lowland streams.

The clarity of the water is well known. Under the proper conditions of natural lighting and surface smoothness, underwater features can be seen at depths of tens of feet. Scientists sometimes test the transparency of water by lowering a Secchi disc (about the size of a dinner plate and painted black and white). In Lake Tahoe, the Secchi disc can sometimes be followed to depths of more than 120 feet. Most streams and lakes contain solid material in the form of small particles of sediment and organic growth that limit visibility to much smaller depths. There is little organic matter in Lake Tahoe.

Under natural conditions, the streams entering Lake Tahoe carry an average of 100 to 250 mg/l of suspended sediment, as do most of the streams in the Sierra Nevada.[1] The bulk of this sediment is transported during the spring snow melt runoff.

The slopes of Lake Tahoe Basin are drained by many small streams; by far, the greatest flow is from the three that enter at the south end of the lake. These are, from east to west, Trout Creek, Upper Truckee River and Taylor Creek. Together, they drain about 36% of the land area of the basin and yield from 40 to 45% of the runoff.[1]

Within the basin there are more than 150 ponds having surface areas of from 1 to 20 acres, about 15 having areas of from 20 to 100 acres, and four larger lakes - Cascade (210 acres), Upper and Lower Echo (330 acres together), Marlett (350 acres) and Fallen Leaf (1,400 acres). The total surface area of these lakes is about 5 square miles; therefore, about 310 square miles of the basin is truly land surface. The surface of Lake Tahoe comprises 191 square miles.[1]

Lake Tahoe water contains some 60 to 70 mg/l of minerals in solution. Most streams in the area that have been studied contain similar concentrations of dissolved solids, so it is reasonable to assume that stream flow entering and leaving the lake has the same characteristics; studies of Truckee River water show about the same concentrations. These values, converted to weights, show that about 30,000 tons of dissolved solids per year on the average enter the lake in stream flow and about 17,000 tons leave it. Precipitation and fallout from soluble dust in the air can be conservatively estimated to add another thousand tons per year of dissolved solids, so that the net increase of minerals in Lake Tahoe is probably about 14,000 tons per year. If all of this mineral remained in solution, concentrations of dissolved solids would increase about 10 mg/l in 100 years; however, there are several physical, chemical and biological processes that remove solutes from the water and, therefore, the actual increase in concentration is considerably slower. The dissolved solids in both the streams and the lake are in the form of ions, mostly bicarbonates silica, calcium, sodium, sulfate and chloride.[1]

I. Air Quality

The California Air Resources Board obtained some values for various air quality components by the use of their mobile laboratories during 1973. Samples were taken for approximately two weeks at each of ten locations scattered throughout the Tahoe Basin. The Air Resources Board's publication "Air Quality in the Tahoe Basin, Summer 1973" has the details of their study.[43] A summary of their study and work done by Caltrans provides the following conclusions.

The major sources of air pollution in the Tahoe Basin are automobiles, wind-blown soil, and hydrocarbons from the vegetation. Due to the emissions from these sources, air quality standards for non-methane hydrocarbons and total suspended particulates were exceeded at several locations in the Basin. The non-methane hydrocarbon standard is exceeded regularly at sites near heavy traffic. Wind-blown material from open areas or construction sites and ash from fires caused particulate loadings to exceed the California air quality standards in 25% of the samples taken in the Air Resources Board's study.

Caltrans gathered particulate data from February 1972 through March 1973 in a rural area of the south end of the basin and found no violations of the air quality standards for particulates or lead. Beginning in July 1974 ozone measurements have been taken at Sugar Pine Point State Park. Since the study began the standard has never been exceeded and only equaled on two occasions.

Studies by the California Air Resources Board shows the ozone levels exceeded the air quality standard on several days. The highest levels occurred when major forest fires were burning outside the basin. The studies also found the air quality standard for lead was reached at one location exposed to heavy traffic. Carbon monoxide and nitrogen dioxide levels did not reach the level of the air quality standards during the study.[43]

It is apparent from these data that the air quality of the Tahoe Basin has degraded, although it remains substantially better than the air quality of the urban areas in California.

Based on the Air Resources Board's estimated emissions within the Tahoe Basin, concentrations of non-methane hydrocarbons will exceed the ambient air quality standards during the summer of 1977 and suspended particulate will remain near the air quality standard. Concentrations of other pollutants should be below the air quality standards.

Due to the fact that the sampling was done at each location for only a short period of time, it is not possible to accurately predict maximum or mean values for the various pollutants throughout the year. The values obtained would only represent the conditions that existed at that time. A much more detailed study would be required to characterize the ambient air quality with a good degree of accuracy.

J. Noise

Noise in the Tahoe Basin from surface transportation sources is primarily seasonal in nature, with the higher noise levels occurring during the summer tourist and vacation period. Existing noise levels during the weekday from September to June are generally lower because of reduced traffic volumes. However, noise levels increase on weekends and during the winter sports season.

The major transportation noise is located alongside State highways and local arterials that provide access to numerous centers of activity. The amount of noise along each highway is essentially a measure of the daily traffic carried by the facility and the number of heavy-duty vehicles mixed within the traffic.

During the winter season, background noise levels decline as traffic decreases and as total human activity levels decline outdoors. Impacts from noise reach minimal values as fewer numbers of citizens are exposed and because living patterns change from outdoors during the warm season to indoors as the weather becomes colder. Precipitation in the form of snow provides an additional element of quiet and solitude. This noise reduction is associated with a psychological response to the pastoral setting and to the reduced background noise levels that occur when a blanket of snow is upon the landscape. The tranquility of this setting is periodically interrupted by winter recreational vehicles, motor vehicles, and by the addition of highway equipment used to remove snow from the highways.

K. Socio-Economic

1. Economic

The economy of that portion of Placer and El Dorado Counties located in the Tahoe Basin is based almost entirely upon tourism. The Tahoe area has been highly successful in capturing the leisure time market by providing a large variety of recreational and entertainment opportunities. Visitors come to the Tahoe area to enjoy its outdoor winter and summer recreational opportunities.

Summertime activities include sightseeing, hiking, bicycling, camping, nature study, picnicking, swimming, boating, fishing and hunting.

Winter activities include Alpine skiing, cross country skiing, snowshoeing, (6 ski areas within the Basin - others nearby) snowmobiling, and snow play areas throughout the Basin.

This attraction for Tahoe's outdoor recreational assets has enabled a secondary industry of gambling and evening entertainment to flourish.

Located on the Stateline on both the North and South Shores are the gambling and night entertainment establishments. The South Shore, by far, has the largest concentration of these types of establishments and has been highly successful in doing an overwhelming volume of business.

The gaming industry at Lake Tahoe is the largest activity attraction in the Basin. Approximately 3.62 million visitor-days were used in gaming during the 1970 year. The income from gaming in 1970 was estimated at 89 million and is expected to increase to 176 million by 1980.[14]

It is estimated that approximately 80% of the motel/hotel casino area business originates from people traveling from the major metropolitan areas of California, such as Sacramento and San Francisco.[13]

Because the Lake Tahoe region is strongly dependent upon outdoor tourism and recreation, much of its business is subject to strong seasonal trends. The major demand for tourist services is concentrated in short summer seasons and on weekends and holidays. However, it can now be said that the resort business in Lake Tahoe now reaches its peak later in the summer than formerly because of the fact that legalized gambling has evened out the tourist season and skiing and other winter sports have helped extend the season.

The South Lake Tahoe Chamber of Commerce is striving to overcome the seasonal cycles. They have adopted the motto "America's All Year-round Playground". They are striving to place more importance on the winter recreational aspects of South Lake Tahoe. This is in hopes of attracting a greater number of recreational tourist-type activities in the winter. This would provide more jobs in the winter and tend to level out the cyclical nature of the employment picture also.

In 1974, the year of energy crisis, Lake Tahoe had one of its better economic years. This is due possibly to the fact that the business people in the Tahoe area coordinated a well devised gasoline availability system for tourists and because short-range trips, such as between Sacramento and Lake Tahoe, were more popular than long vacations due to the shortage of gasoline. In recent months economic indications are that this trend is continuing and that the economic activity at Tahoe is just as great or greater than it ever has been. These facts will continue to play an important part in the economy of the Lake Tahoe Basin.

2. Social

a. Land Use. Historically land use throughout the Tahoe Basin reflects an economic shift from logging and agriculture to tourism and recreation. Dominating private land uses are motels, casinos, shopping centers, "second" homes, concomitant high-rises and condominiums. Apartments and housing subdivisions have sprung up, particularly at the north and south shores of the lake, near gaming resorts. With the exception of areas of concentrated use, the basin is still predominantly undeveloped. However, existing shoreline development has been relatively intense, limiting public access to the lake. U. S. Forest Service, California State Park and private holdings, largely account for the relatively high proportion of open space remaining today. The following table shows the land use distribution in the Lake Tahoe Basin.

LAKE TAHOE BASIN
CALIFORNIA AND NEVADA
MAJOR LAND USAGE--1971[13]

USE	ACRES	PERCENTAGE
Existing 100% Developed	8,239	4.1%
Existing Partially Developed	8,860	4.4%
Unimproved Land	8,770	4.3%
Recreation	6,830	3.4%
General Forest	166,300	82.3%
Existing Lots in General Forest Area	3,000	1.5%
TOTAL LAND AREA	201,999	100.0%

By 1971, over 1,000 camping and trailer sites were either publicly owned or available for public use. 5 developed ski areas within the basin maintain a combined capacity of 11,000 skiers. On all of its forestry lands, the Forest Service tallied almost 2,000,000 visitors days in 1970. Most intensively used areas are located along the shoreline, where roads, service-establishments, and water-based recreation opportunity is located.[19]

Current visitor-days to national forests and camp areas are estimated at 2.2 million and are expected to increase to 4.15 million by 1980 and 5.6 million by 1985. Skiing recreation will increase over the same period from approximately 1,000,000 skier days in 1970 to 2.2 million skier days in 1980 and 3.2 million in 1985. These trends will require new skiing facilities.[19]

b. Transportation and Circulation. A recent tabulation of visitors to the Reno-Lake Tahoe area by mode of conveyance resulted in the following:

MODE OF TRAVEL BY PERCENTAGE 1971[18]

MODE	PERCENTAGE
Automobiles	87.9%
Bus	7.6%
Air	3.1%
Truck	1.2%
Train	0.2%
	100.0%

Nearly all bus passengers visited the area on a resort-planned "club special" basis, mostly from California. Since 1964, automobile visitor growth has averaged some 8% per year over the two main roads leading to the area.[18]

c. Sociology. The City of South Lake Tahoe increased in population by 88.9% between 1960 and 1970; i.e.: from 7,897 persons to 14,919. There were in 1970 possibly 25 or 26,000 permanent inhabitants of the Lake Tahoe Basin, including seasonally employed persons.[18] The following table shows this basinwide population by area.

POPULATION ESTIMATES[18]
PERMANENT RESIDENTS

1960-1970

	1960		1970	
	Number	Percent	Number	Percent
North Shore				
Placer County Portion	3,248	26.5%	6,239	24.1%
Washoe County Portion	100	0.8	1,719	6.6
Total North Shore	3,348	27.3%	7,958	30.7%
South Shore				
El Dorado County Portion	7,897	64.5%	14,919	57.7%
Douglas County Portion	1,017	8.2	3,015	11.6
Total South Shore	8,914	72.7	17,934	69.3
Total for Lake Tahoe	12,262	100.0%	25,892	100.0%

Average Annual Growth Rate: 7.75%

Source: U.S. Census, 1960 and 1970; and
Economics Research Associates.

An overwhelming proportion of visitors to Lake Tahoe originate from western states, especially California. About 75% of all motorists with destinations in the Lake Tahoe area of Nevada are California residents.[18]

In 1970, 211,600 visitor days were spent at the basin's various winter sports sites. This figure represented only 9.2 percent of the total for the entire year, but winter activities grew at an average rate of 7.5% between 1967 and 1970.[18]

d. Political. A Tahoe Regional Planning Compact was adopted by the States of California and Nevada, and ratified by Congress in 1969. Recognizing the region's natural beauty and environmental concerns, it created the bi-state Tahoe Regional Planning Agency with planning and enforcement responsibilities. California Tahoe Regional Planning Agency was reconstituted in 1973 with the initial directive to prepare a regional plan for the California side of the Tahoe Basin. Placer and El Dorado Counties and the City of South Lake Tahoe share responsibility for the California portion of the Lake Tahoe Basin.

ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

III.

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Vegetation

1. General

Plants are closely associated with water quantity and quality. The water cycle, which is the interchange of water with air, plants and land, is vital to all living organisms. It involves evaporation, transpiration, cloud formation, precipitation, surface water runoff, percolation, and accumulation. Removal of vegetation typically increases surface runoff and streamflow. Most soils in the Tahoe region lose stability when stripped of vegetation; in fact, on many steep slopes there is too little vegetation to hold the thin coarse soil against the wind and rain. In such areas precipitation does not remain on the site and quantities of silt find their way into streams and produce turbid low quality water. This releases nutrients to the lake and contributes to the increasing problem of lake eutrophication and the destruction of important habitat for fish and wildlife.

Roadside vegetation has such multipurpose roles as soil erosion control, headlight glare prevention, and aesthetic value. Loss of vegetation increases highway maintenance costs by added labor and the materials used for re-establishing and maintaining plant cover. For example, dead trees must be removed.

In September of 1974 the U.S.F.S. published a report entitled "Conifer Damage and Death Associated with the Use of Deicing Salt in the Lake Tahoe Basin of California and Nevada".[32] The authors estimated that 3,000 conifers 6 feet or taller were killed or damaged at 321 sites. They also state that nearly all the tree damage occurred within 60 feet of the highway. They found that concentrations of salt in needles were several times greater in trees near highways than in trees not exposed to salt. Greenhouse tests revealed that trees treated with salt in water exhibited the same symptoms observed on damaged trees in the field. They concluded that "damage probably will continue to occur if the use of sodium chloride for highway deicing continues at the present level."

In February of 1975 Caltrans conducted a survey of the affected routes within the basin as shown in the U.S.F.S. report to estimate the total tree population which could be affected. There are approximately 75,000 trees represented that lie within 60 feet of the highway and which

are 6 feet or taller. The 3,000 damaged conifers, therefore, would constitute approximately 4% of the total. A research of the pertinent literature reveals most studies dealing with plant injury and death have focused on the sugar maple decline which has occurred over a 16 state area primarily in the New England states.[22] There is no present evidence that the use of deicing chemicals are having any significant deleterious effect to either vegetation or receiving water quality in western Washington state.[23]

In another recent survey 13 states reported damage to plants and/or pollution of water supplies by deicing salts as compared with 12 states reporting no vegetation damage.[24] Some of the states reporting damage use calcium chloride and some use additives both of which are more damaging. California uses sodium chloride with no additives.

A short explanation of the mechanism by which plant absorbs moisture from the soil is in order. Since water enters the root through a membrane, an osmotic pressure gradient is established across the membrane, the magnitude of which depends on the difference in salt concentration on either side of the membrane. The direction of the gradient is such as to cause water to flow naturally across the membrane toward the higher salt concentration. Increasing salinity in the soil, therefore, would make it increasingly more difficult for water to be taken in by the plant.

Since osmotic pressure is a concentration phenomenon, the effect of a given quantity of salt per unit weight of soil depends on the moisture content of the soil. The salts become more concentrated and therefore more detrimental as a wilting percent moisture is approached. The wilting percentage moisture is the minimum moisture content necessary for plant stability below which wilting will occur. The wilting percentage moisture of a sandy soil is lower than that of a finer textured soil. At the wilting percentage, a given quantity of salt is more harmful in a coarse textured soil.[25]

Salt also influences soil structure and nutrient availability. Soil particles have cations and nutrients absorbed on them which can be displaced or exchanged by sodium. This process known as the Cation Exchange Capacity (CEC) reduces the availability of nutrients to plants and binds the soil particles together into a more impermeable layer. The CEC and the influence of salt is determined by particle size with clay being influenced the most by salt, and coarse sand the least.

2. Effect of Salts on Plant Biota

Most of the plant species are much more vulnerable to injury from deicing salts than are animals. Animals and man readily expel excessive salt ingestion by increased water intake and activating the kidneys. Plants do not have mechanisms to expel the excess salts. Roots apparently absorb ions during the winter from unfrozen lower soil horizons even though the plant tops are dormant. Annual application of deicing salts on highways temporarily increases the salt content of soil that receives salt contaminated waters, thus the intake of salt ions from such soils by plant roots year after year augments the accumulation of these ions in plant tissue during successive years. Hence the woody plants may die after absorbing and accumulating the deicing salts for several successive years rather than from absorption during a single year. Salt ions accumulate in woody plants because only limited amounts of the absorbed ion in plant tissue are eliminated through dead plant parts that sever from the live plant tissues.[24]

The effect of salt spray on foliage and plants is not well understood. Dead leaf tissue from such spray is apparently caused by leaf burn from contact with highly ionized deicing salts. In addition such highly ionized salts on surface tissue of plants may cause an extreme diffusion pressure deficit: death may then be associated with desiccation, rapid movement of cell water to salt concentrations or leaves and plasmolyzing of adjacent cells. Salt sprays are most likely to kill plant tissues that are first contacted, however, repeated sprays of salts can be lethal to entire plants.[24]

Grasses are not injured by deicing salts as readily as trees. Trees and woody shrubs usually show specific symptoms of injury from high sodium and high chloride concentrations. Tip and marginal leaf burns (browning) appear first followed by more pronounced leaf burn, leaf droop, stem or twig die back, and finally, death of the plant. Younger twigs are usually damaged sooner than older plant parts. In conifers, morphological symptoms of harmful effects from salts are needle burns and dry, brittle, and dead tissues.[24]

An understanding of plant responses and injuries from salts has been sought since the beginning of agriculture. Yet, because of their complex nature many of these processes are not understood. Plant growth characteristics produced under high salt stress are similar to drought symptoms.[24]

Conifers are reported to be more sensitive to salt injury than are deciduous trees.

Dr. James Neilson of the Institute of Ecology, University of California at Davis, working under a grant from the National Science Foundation, is studying both native and exotic plants in the Tahoe region to determine what species are best adapted to use in revegetating eroded areas. This study is extremely important in view of the low stability of much of the areas topsoil and the difficulty with which plant cover is established in it. The preliminary count of Dr. Nielsen's lists show nearly 450 native and about 110 introduced species of herbs and grasses with non-woody stems; in addition, the list shows approximately 65 native and 50 introduced trees and shrubs. This illustrates the diversity and variety of plant material.

3. Other Effects on Plant Biota

Protecting trees and shrubs is not so easy. Road salt is not the sole cause of damage. Trees standing alone beside roads instead of protected within forests are assaulted more easily by exhaust fumes, by more evaporation due to greater average wind velocity, by abrasive damage from snow removal equipment hurling snow against the foliage, by compacting of soils around the roots and by excessive drainage. However, studies in the state of Maine suggested that sodium and chloride accumulating over the years in soil adversely affect roadside trees and plants.

In research conducted by Snyder et al (1940) in all cases it was noted that the critical factor was soil permeability, regardless of the degree of salinization.[24]

In January of 1971 the American Public Works Association and the Salt Institute in their review of National Cooperative Highway Research Program, report 91, stated that, with regard to vegetation damage, salt may be erroneously blamed for plant injury that is caused by emissions of gasoline and diesel engines.

The Environmental Health Service reports that gaseous pollutants account for the most widespread injury to plant life. Gases known to damage vegetation include ozone, PAN (peroxyacetyl nitrate), nitrogen dioxide, sulfur dioxide, hydrogen fluoride, ethylene and chlorine. These pollutants destroy plant chlorophyll, disrupt the photosynthesis process, and consequently reduce food production.[24]

Many researchers, particularly those in the western U.S. have studied effects of salt on plants and the occurrence and movement of salts through soils. Symptoms of injury in plants and trees include advanced coloration of foliage, leaf scorch, defoliation, stunting, and eventual die off.

Symptoms may, however, be similar whether due to sodium, chloride, high salinity or drought conditions. Chloride per se is not reported to cause adverse effects on soil characteristics although it does add to salinity. Sodium is often considered toxic to trees and other plants with trans-location to the leaves and twigs causing burning and browning. Although thought to be generally non-essential to plant growth, sodium can interfere with uptake of potassium an essential plant element and even serve in its place.

It is extremely advantageous if salts can be leached from the soils before active plant growth starts in the spring. For this reason, a late salt application around the beginning of March may be much more harmful than a heavy mid-winter application.[24]

4. Federal Highway Administration (FHWA) Plant Damage Study

A five year study, financed by the Federal Highway Administration, was undertaken in 1973 to study the effects of deicing salts on terrestrial vegetation and explore other possible causes of plant damage and indicate alternative courses of action.

This study will provide the answers to many of the questions which remained following the investigation made by the U.S. Forest Service. Their report entitled, "Conifer Damage and Death Associated with the Use of Highway Deicing Salt in the Lake Tahoe Region of California and Nevada"[32] pointed up the need for further investigation.

The following proposal was handed out by the U.S.F.S. at a meeting with the Tahoe Regional Planning Agency in August 1974. Most of these recommendations are being covered by the current FHWA financed Plant Damage Study.

> "A PROPOSED RESEARCH AND EVALUATION PROGRAM ON SALT DAMAGE TO ROADSIDE VEGETATION IN THE LAKE TAHOE BASIN.
>
> The Forest Service recently completed a survey of salt-damaged roadside trees in the Lake Tahoe Basin. This survey was primarily diagnostic; it was undertaken to determine the cause of damage, not to determine, except in a general way, the extent of the damage, or the impact of salt damage on the forest. More information is needed before these aspects of the situation can be dealt with properly. This summary is a preliminary listing of projects to supply such information. As yet, none of these are included in Forest Service research or evaluation plans.

-- A survey leading to a quantitative statement of loss.

-- A study on sympton development.

-- A study relating rate of application to damage.

-- A study relating frequency of salt application to damage.

-- A study of plant recovery if salting is stopped.

-- A study of annual rate of damage.

-- A study on the interrelationship of salt damage and other plant diseases.

-- A study on the influence of salt damage on bark beetle populations.

-- A study of the effect of salting on the micro-organisms of the soil and forest litter.

Needless to say, the results of studies such as these would apply more widely than the Tahoe Basin. If forest managers in the Basin and elsewhere feel the need for a more complete biological evaluation of the problem, a more detailed proposal will be prepared.

FOREST SERVICE
Forest Pest Control Staff
630 Sansome Street
San Francisco, California 94111

August 26, 1974"

The FHWA study is essentially divided into two phases: 1) Soil chemistry and salt analysis, and 2) vegetation damage assessment and recommendations for mitigation. The University of California at Davis has contracted to perform that portion of the research dealing with vegetation. The first phase, conducted by Caltrans, has the following objectives:

Quantify salt concentrations in soils at selected sites along roadways where plant damage is prevalent.

Determine typical ozone concentrations.

Develop alternative operational procedures to minimize or alleviate plant damage.

The second phase conducted by The Department of Environmental Horticulture, University of California at Davis, deals primarily with terrestrial vegetation and has the following objectives:

Conduct field surveys of plant damage in the study areas, identify the causes of damage (salinity, air pollution, alteration of environmental conditions, pathogen attack, etc.) and correlate these with the findings of the Translab.

Develop better methods for screening between and within species for salt tolerance and select for more salt tolerance between and within species.

Assist the Translab to develop alternative highway operational procedures to minimize or alleviate plant damage, based on findings of objective 1 and 2 above.

a. Work Being Done by the Translab Environmental Improvement Branch

In the Fall of 1973, Highways 28, 50, 80, 88 and 89 in and around the Tahoe Basin, were reviewed to determine possible sites for intensive investigation. The following criteria were considered in site selection:

Deicing salt application rates

Roadway drainage patterns

Soil type

Topography

Vegetation diversity and age

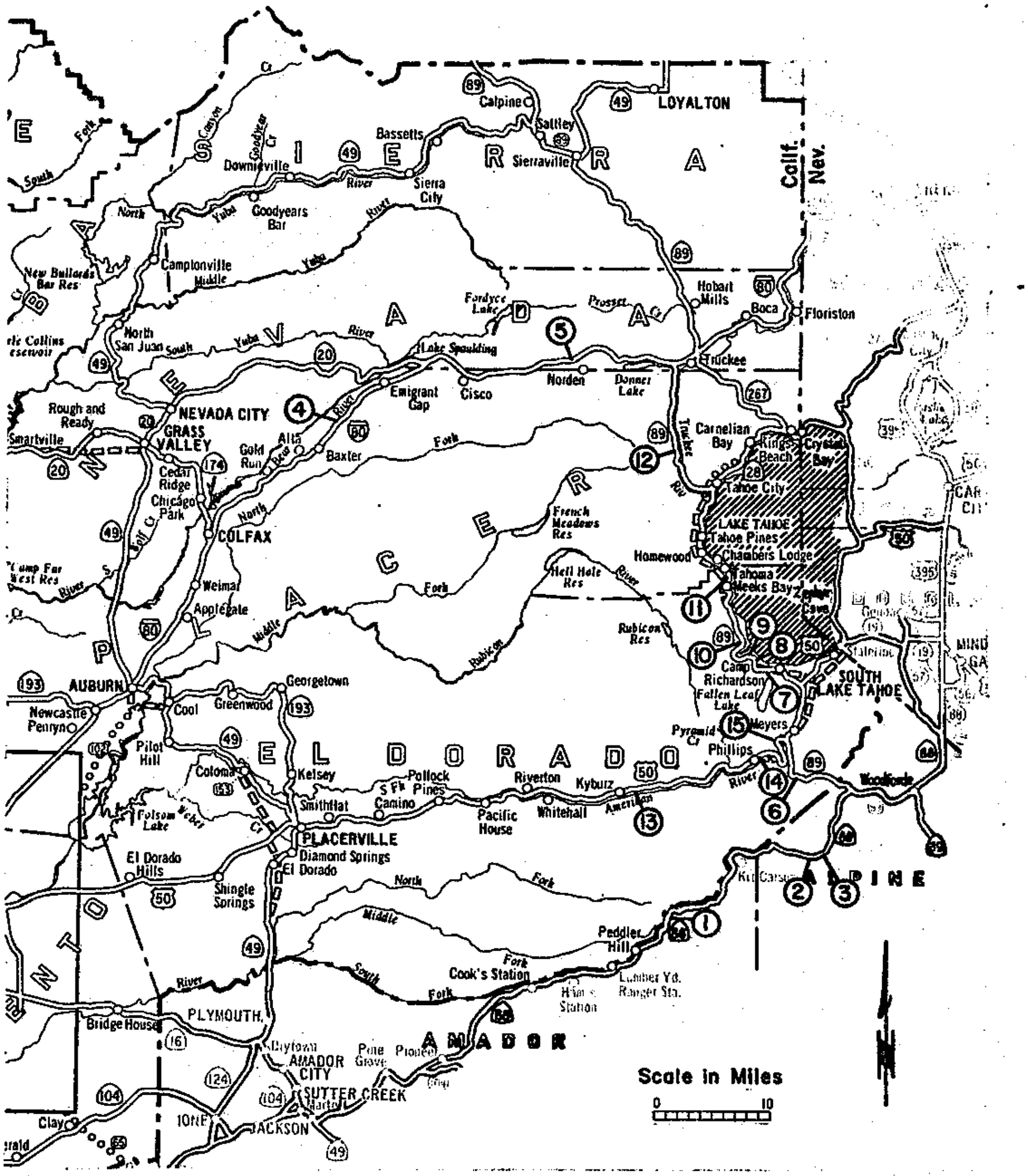
Vegetation damage

Dr. A. T. Leiser, Environmental Horticulturist, U.C.D. and Translab personnel selected 15 sites for intensive investigation (Fig. 4). Soil samples were taken to determine the salt gradient relative to depth and distance from the roadway. Generally, soil samples sites are at the following distances from the edge of pavement: 0, 10, 20, 30, 45, 60, 75, 100, 125, 175, 225, and 300 feet. Discrete samples were taken at increments of 4 or 8 inches to a maximum depth of 3 feet where possible.

To date about 3,000 soil samples have been taken and tested by the Translab.

FIGURE 4

PLANT DAMAGE STUDY SITES



SITE	LOCATION	
1	10-Ama-88	PM 60.5
2	10-Alp-88	PM 4.53
3	10-Alp-88	PM 5.05
4	03-Pla-80	PM 50.26
5	03-Nev-80	PM 3.53
6	03-ED-89	PM 3.98
7	03-ED-89	PM 10.43
8	03-ED-89	PM 14.32
9	03-ED-89	PM 15.47
10	03-ED-89	PM 18.10
11	03-ED-89	PM 26.4
12	03-Pla-89	PM 13.49
13	03-ED-50	PM 51.43
14	03-ED-50	PM 62.63
15	03-ED-50	PM 69.44

Soil samples were initially taken in the Fall of 1973 and again in the Spring of 1974. Only sites 8, 11, and 15 were resampled in the Fall of 1974. The data are presently being computerized for analysis.

Preliminary findings based on the analysis of soil chemistry data indicate that chloride and sodium concentrations generally decrease with increased distance from the roadway. Ambient salt concentrations were generally reached at 50 feet to 150 feet from the edge of pavement depending upon site topography. This is supported in the literature by other investigators.

Site topography was mapped to show drainage patterns and other topographic features. The resulting maps were used by the U.C.D. researchers to plot vegetation at each site.

Deicing salt applications records are being compiled for every site by Maintenance personnel. These records will indicate relative deicing salt loadings which may be correlated with salt concentrations in the soil and vegetation damage. SSnowfall records are also being compiled to determine relative amounts of winter precipitation for annual comparison. Salt concentrations in snow melt and roadway runoff are being monitored periodically. Salt concentrations in runoff vary greatly depending upon the particular drainage sampled.

Snow adjacent to the roadway is also being monitored for salt concentrations to determine snow removal patterns. Generally, the samples are taken along the soil sample transect perpendicular to the roadway centerline. Preliminary indications, from limited tests, are that the levels are highest adjacent to the roadway and decrease to ambient levels at about 50 to 150 feet from the edge of pavement depending upon site topography.

Ozone concentrations and meteorological data are being monitored at one site on Highway 89 at Sugar Pine Point campground located near the west shore of Lake Tahoe. The Dasibi ozone monitoring unit was provided by the U. S. Forest Service as part of a statewide monitoring program. The California Department of Parks and Recreation have provided support in housing and servicing the equipment located in the campground.

Preliminary ozone concentration data indicate the levels are below U.S. Environmental Protection Agency Air Quality Standards of .08 ppm hourly average. (.08 ppm ozone concentrations are considered threshold for human health)

b. Work Being Done by the University of California, Davis, Department of Horticulture

The U.C.D. research group, headed by Dr. A. T. Leiser, conducted a vegetation survey at all sites, mapping and recording species, size, age and condition of the plant spectrum. The following is a partial listing of plants surveyed:

Pinus jeffreyi, Jeffery pine
P. ponderosa, Ponderosa pine
P. lambertiana, Sugar pine
P. contorta var murryana, Lodgepole pine
Calocedrus decurren, Incense cedar
Populus tremuloides, Quaking aspen
Abies concolor, White fir
A. magnifica, Red fir
Arctostaphylos nevadensis, Pine mat manzanita
Ceanothus prostratus, Squaw carpet
Penstemon newberryi, Mountain pride
Sambucus microbotrys Mountain elderberry

Those plants showing symptoms of damage will be diagnosed as to cause. Initial surveys indicate some species exhibiting distress symptoms, seemingly independent of distance from roadside.

Distressed White Fir were found near the road with severe bark beetle damage and with mechanical damage due to recent underground construction for sewer pipelines. Tissue analysis has not yet been run on these trees, but is planned. A number of species adjacent to the roadway at other test sites, were found to be totally lacking in distress symptoms. The appearance of distress symptoms is random.

In a survey for pathogens, conducted on dead and dying trees in the highway corridor, about 60% of 50 trees examined were found to have pathogenic infections. Some of these trees had been removed by highway maintenance crews as safety hazards. *Armillaria mellea*, (oak root or shoestring root rot pathogen) was isolated from numerous trees including White Fir, Red Fir and Jeffrey Pine. Another pathogen called *Pythium sp.* was isolated from one Incense Cedar.

Further inventories will be made to determine percentage of populations with root rot, bark beetle, high salt concentrations in foliage or other pathogenic or physiological problems.

Greenhouse studies are being conducted to develop salt damage symptoms in additional plant species. Salinity tolerance levels are also being determined for plant species in the study area.

The existence of pathogenic interactions between various vegetation stresses and salt will be determined. Answers to questions such as the affect of root rot infection on the assimilation of salts and of the affect of salt stress on the infectivity by root rot pathogens will be explored.

Ten plant species were grown under greenhouse conditions during the summer, and their growth response to salinity was compared. The plants used were 4 herbaceous crop species: sunflower, beans, barley and chrysanthemum; two low altitude woody species: Liquidambar and Monterey pine; 4 species of the Tahoe Basin; Mountain pride, Pine Mat Manzanita, Mountain Elderberry and Squaw Carpet. The plants were irrigated daily with a nutrient solution containing 0, 20, 40, 80, 120, and 160 meq/l of an equivalent mixture of NaCl and $CaCl_2$. After plants had grown sufficiently to establish yield differences between treatments, they were harvested and fresh and dry weight yields were recorded. During the growth period notes were taken on the time required for salt damage to appear and on the symptoms of salt injury.

To compare the response of all species, relative yield is used. The relative yield is (treatment yield) x 100/(control yield). We have generalized the yield response to salinity into three groups: most sensitive (Pine Mat Manzanita), moderately sensitive (Penstemon, Monterey pine, Liquidambar and Squaw Carpet) and least sensitive (Herbaceous crop species). When salts were added, plants did not wilt, therefore, we assume that all species adjusted to the osmotic environment. Osmotic stress causes reduction in growth of almost all species and reduced growth would be anticipated. For the woody species it is not believed, however, that the osmotic stress was the major factor in yield reduction. In all cases leaf necrosis (death to living tissue) occurred first in the highest salt treatment, followed by the next highest level.

It is believed that the time course and symptoms of injury are a result of specific ion toxicity from Na and/or Cl. The variability in time before injury appeared for different species may reflect the ability to exclude the toxic ions.

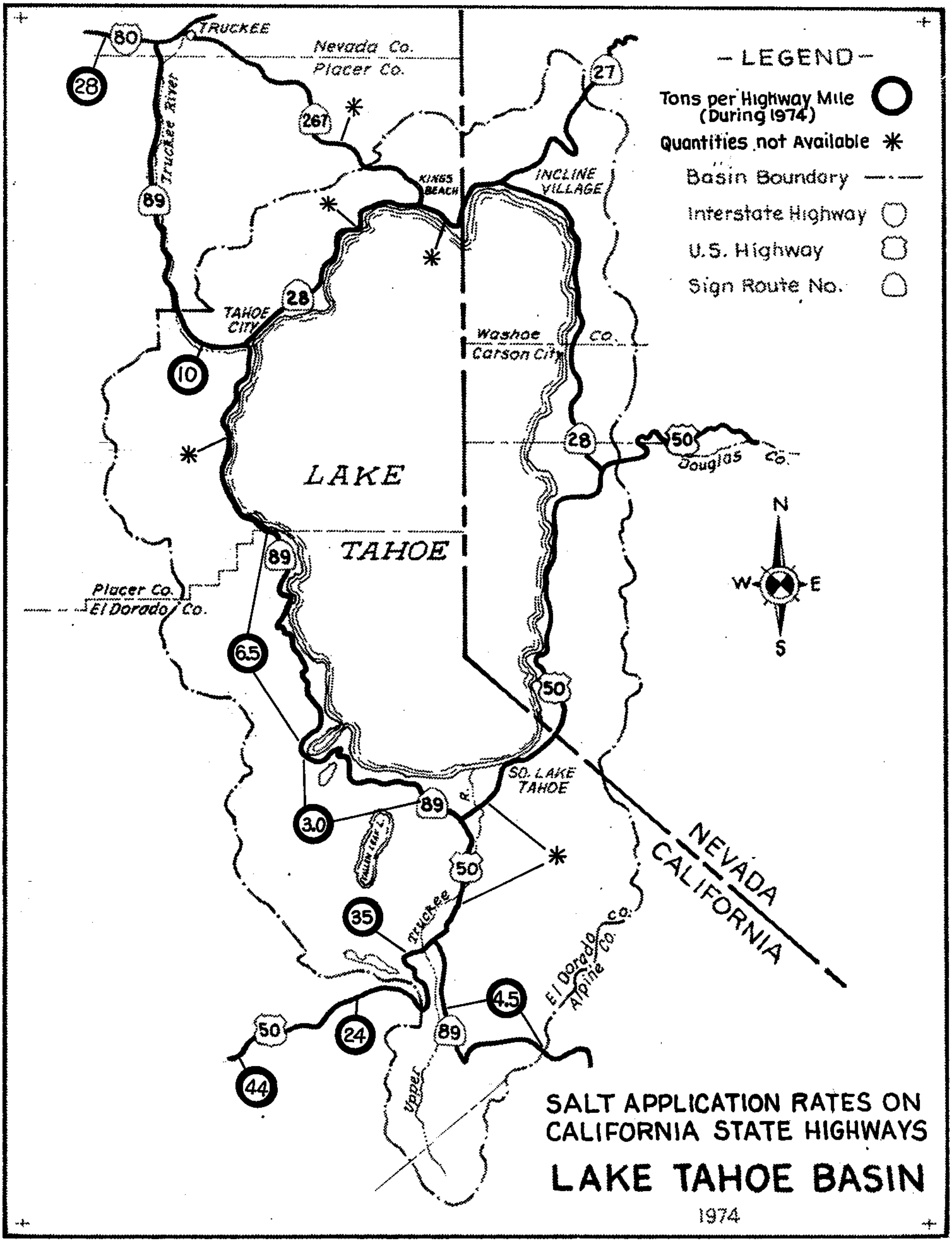
The information analyzed to date indicates that there are many factors to be considered in assessing the cause for distressed vegetation along roadways subjected to winter salting. Root rot and other diseases were found to be prevalent in areas of the highway corridor surveyed. Preliminary indications from two sample sites are that the salt is not accumulating in the upper three feet of the soil horizon. This is important because for good soils 1/2 to 3/4 of the functional tree roots (i.e. roots that take up water and nutrients) are located in the upper 3 to 4 feet of the soil horizon. The soil chemistry data will be analyzed to determine relationships between various parameters and distance from the roadway and depth from surface. This and other deicing salt information will be provided to the U.C.D. researchers for use in the analysis of plant damage and viable alternatives.

After the ongoing research is completed and all the analysis made, it may be found that highway deicing salt is the primary cause of plant damage, and on the other hand it may be found that the salt is an insignificant contributor. More likely the answer will fall somewhere between the two extremes.

If the salt is not found to be significantly responsible, hopefully the real cause will have been identified or delineated. Alternatives that may warrant consideration are discussed in Section V of this report. In the event that salt is found to be the primary damaging agent, alternatives will have to be adopted or mitigation measures employed that will control the damage within acceptable limits. An interim report on "Highway Operation and Plant Damage" will be published in summer 1975, by Caltrans.

As part of this study, records on salt usage were maintained for sections of roadway where study sites are located. Figure 5 shows the application rates in tons per highway mile during 1974. It should be noted that application rates are considerably lower on Route 89 than on Route 50. This is largely due to differences in traffic volumes and/or demand.

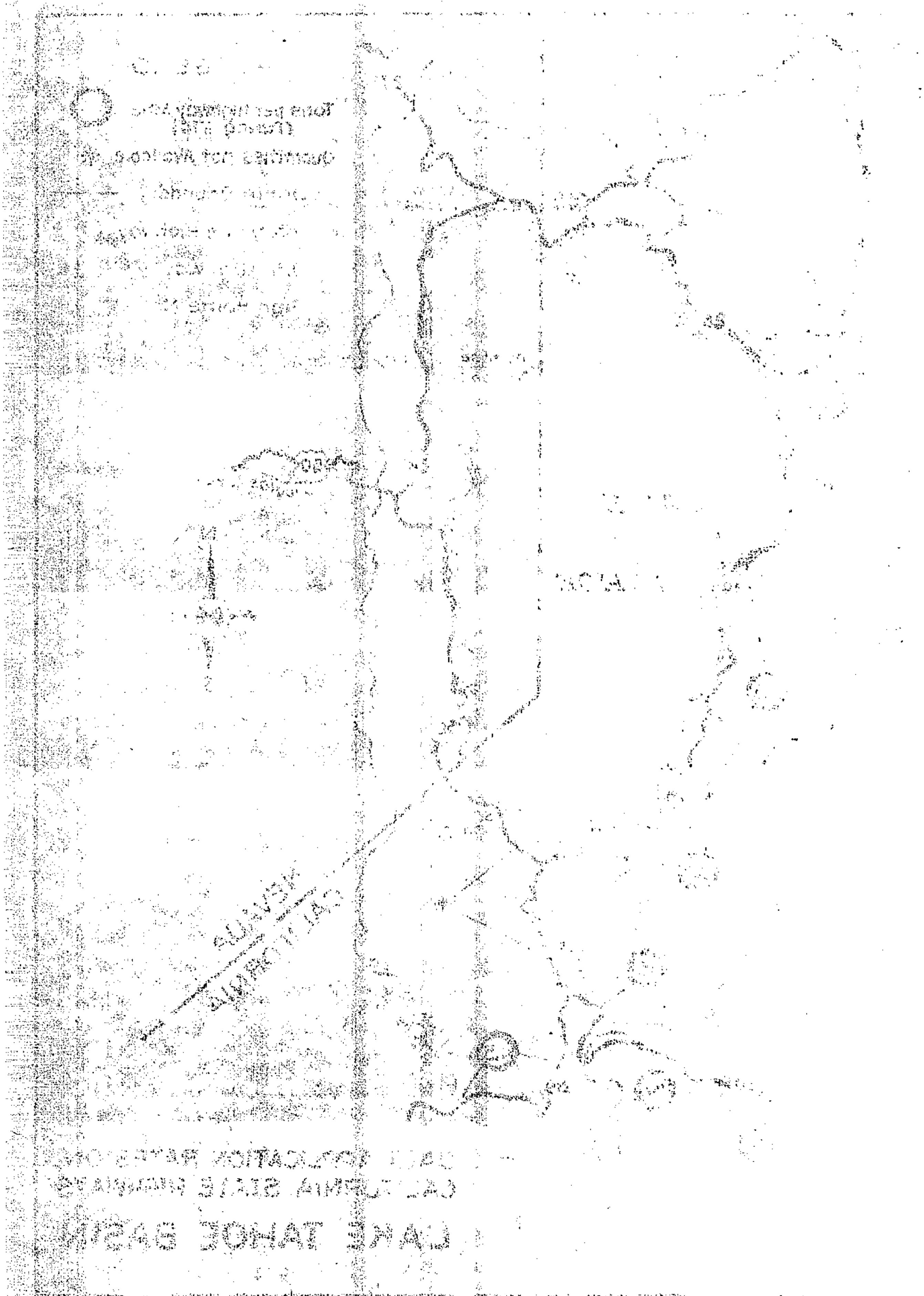
FIGURE 5



SALT APPLICATION RATES ON CALIFORNIA STATE HIGHWAYS

LAKE TAHOE BASIN

1974


LAKE TAHOE BASIN
CALIFORNIA STATE HIGHWAYS
NEVADA
CALIFORNIA

B. Water Quality

1. General

Water quality of Lake Tahoe or its tributaries could be affected by the use of deicing salt in several ways. Excessive concentrations of sodium chloride can influence productivity and eutrophication rates in aquatic ecosystems as well as affecting the living organisms including fish. A possible secondary effect on water quality would come from a loss of vegetative cover and subsequent vulnerability to erosion which could cause sediment to be carried into waterways and the Lake.

2. Movement of Sodium Chloride (NaCl)

The winter maintenance operations of Caltrans involves the application of NaCl to roadway surfaces. This salt then moves through the environment.

The precise pathway of NaCl through the environment is not known at this time. In this case, to provide a wide margin of safety we shall assume conditions that represent the greatest potential for damage to the environment. For the purposes of examining impacts upon the aquatic environment, this section shall assume all salt reaches watercourses by two means, (1) subsurface drainage and (2) direct drainage. Salt applied to the roadway might drain off onto roadside soils or might be picked up and transported by plows or blowers away from the roadway. In either case, the salt eventually dissolves in runoff water and percolates into the soil or is carried into local streams. The sodium and chloride ions are then subjected to the soil's ionic exchange capacity while moving through the soil and into the subsurface and groundwaters. Since watercourses act as collectors for these subsurface flows in mountainous areas, Na and Cl eventually enter the aquatic environment.

This transport process may take considerable time so that an average year-round input of salt, with only cyclic fluctuations, actually enters the watercourse.[52] This results in raising the overall concentration of sodium and chloride ions in the stream on a long-term basis.

The other method is direct drainage of salt into the watercourses. This may occur when the salt dissolves in surface runoff, collects in roadside ditches and culverts and then enters the watercourse directly. Peak salt concentrations in the roadside drainage may be much higher than in streams but input is for a much shorter time period.

This results in locally higher concentrations of salt downstream of the outfall. Turbulence and eddy diffusion quickly mix the salt laterally and vertically in the stream so that the peak concentration is only a local effect.

Another area of concern is the use of snow storage or snow disposal sites to which plowed snow may be hauled and dumped. Caltrans presently operates four such sites in the Tahoe region. Sampling of the snow in these sites shows an average concentration of 25 ppm NaCl.[42]

The upper Truckee River is typical of streams in the Tahoe Basin. It has a Cl^- concentration varying between 1 ppm and 8.5 ppm (early fall). The Lower Truckee River has a fairly constant concentration of almost 10 ppm.[4] This higher level is due in large part to input from a sewage treatment plant nearby. The average value of Lake Tahoe water is 2.6 ppm Cl^-.[4] To help understand the relative magnitude of salt and water involved, an increase in NaCl concentration in Lake Tahoe can be calculated. Making the gross assumptions that:

1) All salt applied in the Tahoe Basin ends up in Lake Tahoe;

2) There is no output;

3) There is an even distribution; and

4) The average application rate of 1461 tons/year (10 year average) is continued into the future.

The total increase in concentration of NaCl in Lake Tahoe over the next 50 years would then be approximately 0.44 ppm. The total concentration would still be below the maximum of 5 ppm Cl^- set by the Lahontan Water Quality Control Board.

Associated with the use of salt is the storage of salt. Some salt storage practices allow salt to be stockpiled outdoors, uncovered. Runoff from such piles would be tremendously high in NaCl. The practice of Caltrans is to store salt in dry, covered, properly drained areas. Sampling has shown that there is no problem with runoff from salt storage sites in California.[55] Caltrans uses only sodium chloride in its deicing operations and does not add any anticaking or rust inhibitors to its deicing salt.

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3) There is an even distribution; and

4) The average application rate of 1461 tons/year (10 year average) is continued into the future.

The total increase in concentration of NaCl in Lake Tahoe over the next 50 years would then be approximately 0.44 ppm. The total concentration would still be below the maximum of 5 ppm Cl^- set by the Lahontan Water Quality Control Board.

Associated with the use of salt is the storage of salt. Some salt storage practices allow salt to be stockpiled outdoors, uncovered. Runoff from such piles would be tremendously high in NaCl. The practice of Caltrans is to store salt in dry, covered, properly drained areas. Sampling has shown that there is no problem with runoff from salt storage sites in California.[55] Caltrans uses only sodium chloride in its deicing operations and does not add any anticaking or rust inhibitors to its deicing salt.

3. Data Collection

There is a need or data pertaining to the effects of highway salts on the aquatic environment and to the fate of deicing chemicals in the environment and their ability to stimulate or inhibit growth of aquatic organisms adapted to water with low salt content. Undesirable accelerated algal growth may be triggered by the addition of minute amounts of essential elements contained in road salts, the absence of which is a limit to growth. In addition, care must be taken to ensure that a substitute compound for deicing salt will not be more of an environmental problem than salt.

This need prompted Caltrans to contract a study with Dr. Charles Goldman of Ecological Research Associates to study the influence of highway deicing salt and other deicing compounds on aquatic environments. The two year project is slated for completion in late 1975.

The study is being conducted in the Lake Tahoe Basin and drainages along Interstate 80 and Highway 89 in the Sierra Nevada region (Figure 6) and will satisfy the following four objectives:

1) Determine the influence of deicing materials on productivity and eutrophication rates in aquatic ecosystems.

2) Investigate the effects of deicing materials on the physical aspects of aquatic ecosystems.

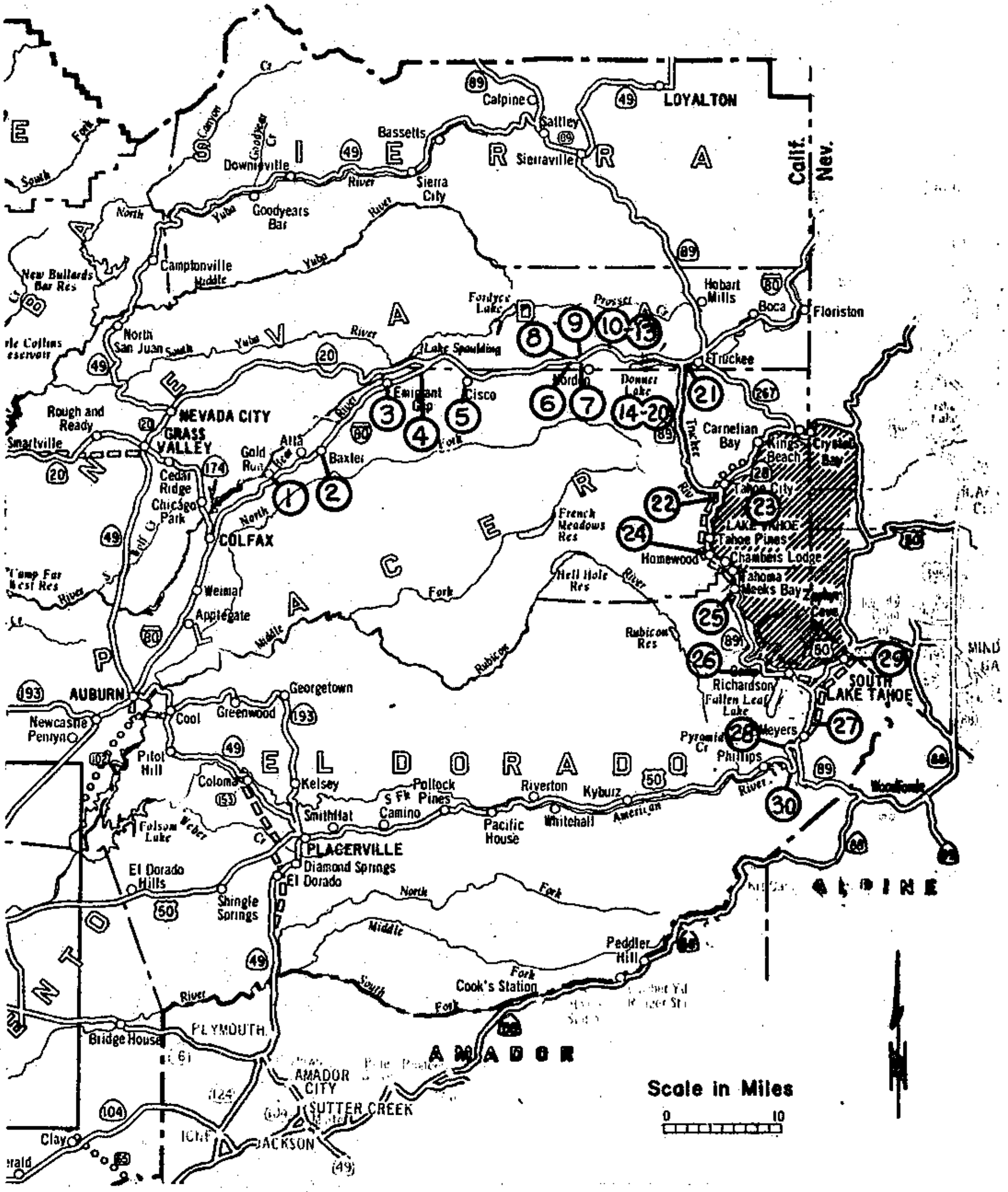
3) Determine the present distribution of road salt in specific lakes and ponds.

4) Analyze road salt for important trace element contaminants.

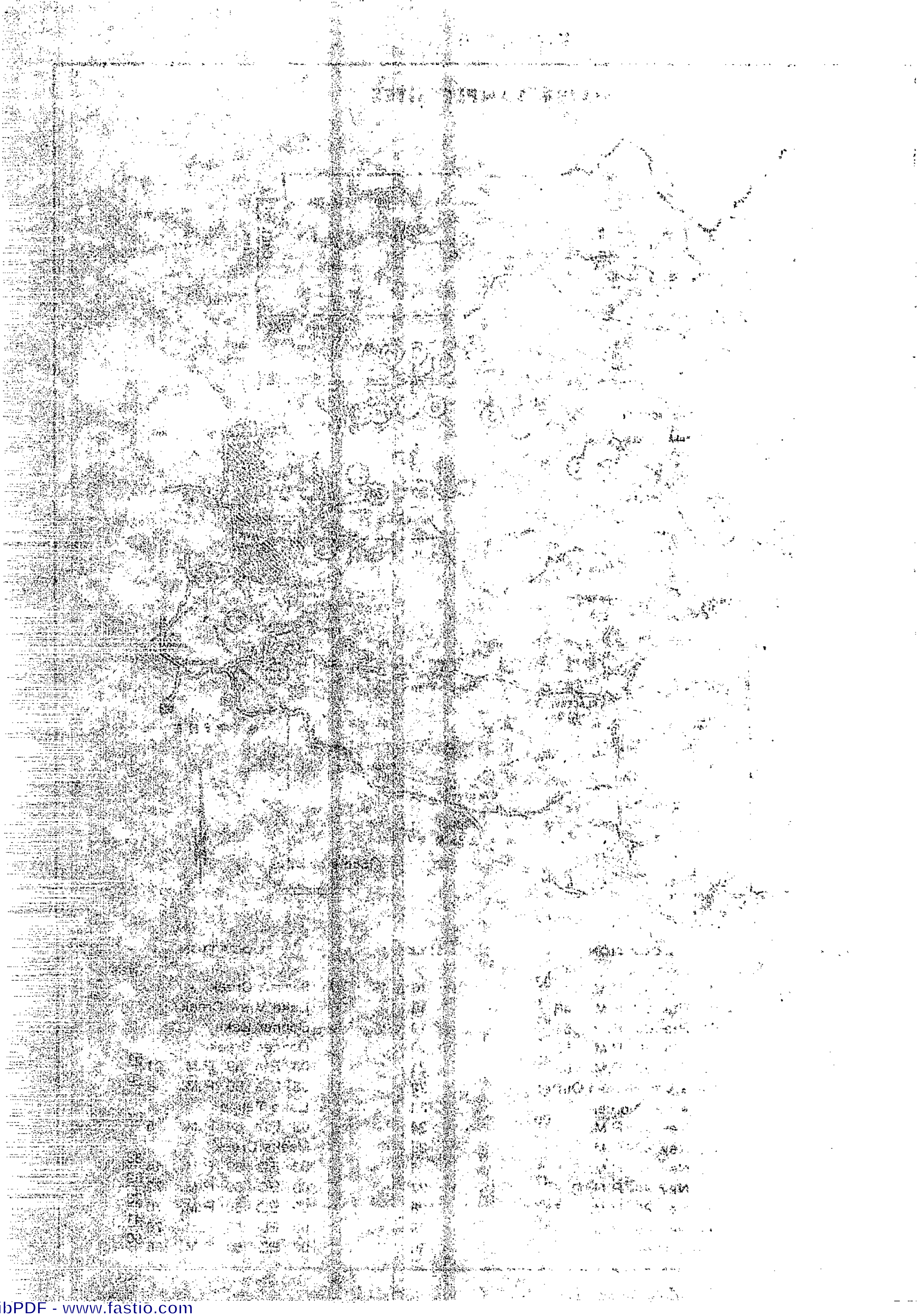
Sampling surveys are being conducted every two weeks, beginning in August of 1974 at various locations, to measure the conductivity of the water. Estimations of the total dissolved salts can be made from this monitoring. The survey is a comparison of normal levels of sodium chloride in water samples compared with those areas receiving applications of road salt. For example, a stream which is crossed by a road receiving salt will be sampled above any drainage from the road to determine ambient salt levels and sampled below the road to determine the contribution from the road. Analysis from sodium (Na), and chloride (Cl) are easily determined.

FIGURE 6

WATER SAMPLE SITES



SITE	LOCATION	SITE	LOCATION
1	03 Pla 80 P.M. 42$^{\underline{66}}$	16 & 17	Summit Creek
2	03 Pla 80 P.M. 46$^{\underline{00}}$	18	Lake View Creek
3	03 Pla 80 P.M. 54$^{\underline{81}}$	19	Donner Lake
4	03 Pla 80 P.M. 56$^{\underline{06}}$	20	Donner Creek
5	03 Pla 80 P.M. 63$^{\underline{43}}$	21	03 Pla 89 P.M. 21$^{\underline{51}}$
6	Lake Van Norden Outlet	22	03 Pla 89 P.M. 8$^{\underline{46}}$
7	Lake Van Norden	23	Lake Tahoe
8	03 Nev 80 P.M. 4$^{\underline{00}}$	24	03 Pla 89 P.M. 5$^{\underline{84}}$
9	03 Nev 80 P.M. 4$^{\underline{11}}$	25	Meeks Creek
10	03 Nev 80 P.M. B 5$^{\underline{70}}$	26	03 ED 89 P.M. 14$^{\underline{83}}$
11	03 Nev 80 P.M. B 5$^{\underline{47}}$	27	03 ED 50 P.M. 72$^{\underline{69}}$
12	03 Nev 80 P.M. 6$^{\underline{00}}$	28	03 ED 50 P.M. 70$^{\underline{23}}$
13	03 Nev 80 P.M. 6$^{\underline{00}}$	29	03 ED 50 P.M. 76$^{\underline{41}}$
14 & 15	Negro Creek	30	03 ED 50 P.M. 68$^{\underline{50}}$



To date, no pattern of consistent stratification has been noted in any lake except Donner near Truckee. Donner Lake displays a fairly constant pattern of lower chloride levels in the upper waters, but this does not indicate stratification due to salinity. The lower chloride levels correspond with the higher temperatures of the epilimnion. (Donner Lake is not in the Tahoe Basin)

Lake Tahoe has consistently shown a constant chloride level from the surface to 450 meters with no indication of a density gradient forming.

All lakes studied showed higher salt levels than those found in control lakes but there is no indication of any salt gradient developing, except temporarily in Putts Lake adjacent to Interstate Highway 80. (Putts Lake is not in the Tahoe Basin) This is a shallow lake and lies within 100 feet of the freeway at an elevation of just over 5,000 feet.

In the 10 streams being studied, chloride levels were extremely variable and corresponded with weather and salt application activity. Runoff from roads where salt was used, did increase the salt content of streams associated with the road. When salt was not used, chloride levels were not detectable in the study streams.

The most significant findings from Caltrans' aquatic studies thus far has concerned the trace element contaminants in some of the salts being used for deicing procedures. In the salts being used within the Tahoe Basin most trace element contaminants are very low compared to salts used in the southern portion of the state. Lead and mercury contaminants, which are known to be detrimental to biological systems, range from .08 -.09 parts per million (ppm) and .03 - .05 ppm respectively. It is anticipated these low levels will have very little if any affects on Lake Tahoe's aquatic ecology.

The most important trace element contaminant found is iron which ranges between 0.3 ppm and 8 ppm. Dr. Goldman's past research on the Tahoe region has identified iron as a limiting factor of the algae productivity in the Tahoe Basin. The addition of iron contaminated salts may have an effect on some of the lake's algae populations which would be evidenced by increased algal growth. Whether the level of iron in road salts is high enough to warrant consideration of this problem will necessitate completion of scheduled bioassays being used in the current research project.

The Lahontan Regional Water Quality Control Board has stated that their testing has not indicated any problems, with regard to chloride levels, in the tributaries to the lake or Lake Tahoe itself. Chloride levels in the Truckee River, between Tahoe City and Truckee, at times does exceed allowable limits specified in the interim plan. New criterion is being developed at the present time.

An interim report on "Effects of Highway Deicing Agents on Aquatic Environment" will be published in summer 1975, by Caltrans.

4. Probable Impacts Upon the Aquatic Biota

Both sodium and chloride ions naturally occur in the aquatic environment. Rain and snow can deposit 35 to 40 pounds of chlorine per acre each year. Plants and animals require small amounts of both ions for their biological processes. Like all other materials, these ions can be toxic if present in concentrations too high. This level, or maximum tolerance level, varies from species to species.[8]

The following is a short discussion of different tolerances compared with the maximum level of Cl^- for drinking water as established by the Public Health Service, 250 ppm Cl^-.

Most NaCl tolerances established for fish have been in the range of 3800 ppm for whitefish, 5800 ppm for salmon eggs and stickleback young, 9100 ppm for perch, and up to 25,000 ppm for trout.[8] Most of these values are difficult to interpret due to the lack of explanatory data. The test species were not the same as occur in the Tahoe Basin, although simple predictions regarding the species in question can be made. The game fish in the Tahoe Basin are members of the trout-salmon family. Several members of this family are able to survive in both fresh and sea water (approximately 35,000 ppm total salts) at different times in their life cycles. The non-game fish normally are fairly adaptable to varying environmental conditions. The tolerance of fish to a toxic material can be increased if the fish are exposed to progressively higher concentrations of the material over time. This is known as acclimatization. This is important in two respects. The fish in the Tahoe Basin will become acclimatized to higher concentrations of NaCl as its concentration slowly increases. There is a limit to adjustment, however. Conversely, fish may react adversely to slug doses, or temporarily high concentrations, even if such doses are below the conceivable maximum tolerance level.

Another aspect often not reflected in tolerance levels is long-term, sublethal effects. A given concentration may not be fatal to an organism but it may cause physiological changes that would alter behaviour, such as a shift in reproduction cycles or increased metabolism. Sodium chloride has been shown to have an antagonistic effect with other salts. Sodium chloride will actually reduce the toxicity of other salts when in combination with them.[9,10] The data indicate that the species of fish found in the Tahoe Basin would probably be unaffected by levels of NaCl below 1000 ppm and most certainly below 250 ppm.[8] It is interesting to note that the California Department of Fish and Game recommends the use of NaCl in one of their operations manuals (Fish Bulletin #107) as a prophylactic treatment of fish eggs and fish during spawning at levels up to 7500 ppm, and as a control measure for some fish diseases and parasites at levels up to 30,000 ppm. As a comparison to other waters in the U.S., 95% of all inland waters supporting a good mixed fish fauna exceed a dissolved solids concentration of 72 ppm and 50% exceed 169 ppm; 95% of these waters have chloride concentrations below 170 ppm and 50% are below 9 ppm.[8]

The information regarding other aquatic life forms, such as macroinvertebrates, plankton, and aquatic plants, is less descriptive. One researcher found levels of NaCl only above 3,000 ppm to be deleterious to fish-food organisms and fish fry.[8] The values would probably be much lower for Lake Tahoe since the test was run with water from Lake Erie. Another study demonstrated maximum tolerance for a species of Daphnia similar to those found in Lake Tahoe to be 800 ppm NaCl at 3°C. (37°F.). This tolerance decreased to about 400 ppm at 20°C (68°F.).[8] Several species of caddis fly larvae were shown to tolerate up to 26,000 ppm NaCl.[15] These species appear to be the most sensitive found so far.[8,16,17,54] Without more specific research, it is difficult to make definite conclusions, but it appears that levels of NaCl below 250 ppm would have little probable toxic effect. The only area in question might be locally high concentrations of NaCl in streams occurring downstream of drainage outfalls. At this time, it is not known if this represents a problem or not. On the other hand, one researcher suggested increasing sodium levels might act as a growth stimulant. While this is within the realm of possibility, its validity and applicability in the Tahoe Basin is in question. In fact, nutrients other than sodium have been shown to be limiting factors in the Tahoe Basin.[53]

A researcher recently demonstrated that sodium may tend to release mercury from stream sediments. Mercury is extremely toxic to aquatic life. However, the levels of salt needed to produce an effect are considerably greater than would be found in a stream in the Tahoe Basin. The probable impact of salting operations in this respect would most likely be insignificant.[55]

5. Summary

The overall evidence indicates that the probable impact of NaCl upon the aquatic environment is most likely insignificant. However, this cannot be definitely shown without the results of current and future research efforts. If an impact were to be significant, it might only occur in areas of locally high concentrations of NaCl in streams near drainage outfalls. Only the most sensitive benthic (bottom dwelling) organisms might be affected. Consultation with personnel from both the California Department of Fish and Game and the Lahontan Water Quality Control Board indicates they do not consider road deicing to have a significant impact on the aquatic environment.

C. Terrestrial Wildlife

1. Wildlife Habitats

The use of highway deicing salt (sodium chloride) may adversely affect wildlife if it causes a decline in the quality or abundance of any one of the essential habitat components such as forage, cover or water. Since vegetation is the most important element of the habitat for many wildlife species, the greatest potential for adverse impact may be salt induced plant damage or exclusion of particular plant species. Several species of grasses, forbs and shrubs which furnish valuable forage, cover and nesting sites for wildlife may be adversely affected by the use of salt in the Tahoe Basin.

However, the use of deicing salt on highways in the area would primarily involve only that wildlife habitat which is found within the disturbed areas directly adjacent to existing highways. These areas are of limited value as they are utilized primarily by the less sensitive species. Consultation with the California Fish and Game, Wildlife Investigations Laboratory in Sacramento, revealed no conclusive evidence of salt damage to terrestrial wildlife habitats in California.

The potential for vegetation damage resulting from the use of highway deicing salt is thought to be directly related to the amount of salt used, the amount of fresh water flushing through the system, the seasonal salt levels present and the vertical and horizontal distribution of salt in the soil environment[47,49]. Therefore, the potential for wildlife habitat damage would be expected to decrease as distance from the highway increases.

2. Direct and Physiological Impacts on Wildlife

Animals require sodium and chloride ions in small amounts for normal physiological functions. Consumption of salt in nature varies between animal species and in relationship with factors such as age, condition, season of the year, salt content of the diet and quality and quantity of available salt. Herbivorous species may consume more salt when an abundance of succulent, green forage is available and less salt when the diet is restricted to drier, woody forage. Based on studies of domestic livestock and some species of wildlife, it is generally recommended that they be provided drinking water of a quality safe for human consumption to prevent possible health problems.[8] When natural salt deposits are readily available to wildlife, they show little interest in artificial sources. However, in locations poor in natural sources, salt has been shown to attract wild animals.[46]

Based on available information, it does not appear that salt, selectively applied to highways in the Tahoe Basin will directly produce significant adverse impacts on wildlife. Toxicity and attraction of wildlife to highways, as described by Trainer and Karstad,[51] is not expected to be a problem. These investigators examined pheasants, quail and rabbits which reportedly died as a result of salt poisoning. The salt involved, however, was found to contain ferric ferrocyanide, a potentially toxic additive, which is added as an anticaking agent. This is not used by Caltrans.

There exists the possibility that some species of wildlife may be attracted to readily available salt along highways.[50] Among these animals, deer and some species of gamebirds and songbirds are most likely to be involved. However, deer migrate out of the Tahoe Basin during the fall and are, therefore, not subject to the attraction of salt applied during the winter months. Small mammals and birds which remain in the area during the winter could be affected by the presence of salt as they may actively seek available sources of salt during this season.

Unrestricted use of salt could disrupt the system at various levels. For example, salt stress or damage to plants, the primary producers, would affect the food availability for the herbivores, the initial consumer level in the ecosystem. This negative effect would then be passed on to higher consumer levels. Without a thorough understanding of these inter-relationships, investigators can only speculate as to the actual impacts of salt on the wildlife of a given area.

D. Mitigation (Vegetation, Water and Wildlife)

For the purposes of this report mitigations will include those measures that would reduce or eliminate the adverse effects that the use of salt might have on roadside vegetation, water quality and other elements of the environment. Items that constitute alternative actions are discussed in Section V.

1. Prewetting

One method to reduce the amount of salt used on the highway is to prewet the salt with a liquid chemical such as calcium chloride. The prewetting of salt results in a quicker ice melting and less salt waste because the prewetted salt does not bounce and scatter and it provides a greater temperature range in which salt can be used. The calcium chloride solution is the prewetting liquid most often used.[28] This prewetted salt remains in granular form but has the characteristic of being softer and more readily changed to brine. This possibility is being considered at present along with possible adverse effects of the calcium chloride on the environment.

2. Direct Application of Liquid Chemical

Salt brine or calcium chloride solution applied directly results in quicker melting and less use of chemical.[28] These are also being studied.

3. Calibration of Spreaders

Calibration is essential for controlling application rates. Various methods can be used but it is important to calibrate each piece of equipment as no two pieces are likely to be the same. Devices to relate spreading directly to groundspeed have been credited with reducing chemical use. These devices deliver a preset amount of chemical per unit area regardless of truck speed.[28] Calibration has been accomplished on all equipment used in the Tahoe Basin.

Caltrans has purchased an electronic control system for use on sanding trucks which guarantees a predetermined spread rate of sand or cinders and salt on the roadway regardless of vehicle speed. This is called a duo-servo closed loop ground oriented spreader control system. One of these units has been in use at the Truckee maintenance station for the last two winters. Another one is now on order for use at the South Tahoe maintenance station. The spread rate on the one in use has been set at 1330 pounds per mile total for sand, cinders and salt. The available range is somewhere in the neighborhood of 800 to 1800 pounds per mile. The spread rate is maintained at vehicle speeds of 1 mile per hour to 25 miles per hour.

4. Better Management Control

Establishment of levels of service, standards for chemical application and the reporting procedures give management better control over the use of chemicals.[28]

5. Training

Many maintenance engineers believe that training personnel involved with snow and ice control is one of the most important factors in controlling chemical use. Comprehensive training programs should be organized.[28]

Carefully controlled applications of salt according to calculated need by the skilled operators will minimize environmental contamination.[29]

6. Adequate Weather Forecasts

The most significant factor in starting snow and ice control operations is adequate warning of an approaching storm. Caltrans has contracted for the 1974-75 winter season with private weather forecasters, to acquire the most accurate up-to-date predictions.

7. Increase Tolerance

Bartlett (1962) stated that evergreens sprayed with antidesiccants could be protected against winter injury and salt spray. Spraying must be done when the temperature of the plants is above 40° Fahrenheit and preferably on a sunny day. The spray prevented rapid drying out or loss of moisture through the needles under high desiccating winds.[41]

An increased salt tolerance of plants can be achieved with a hardening process. Seeds soaked in dilute sodium chloride ($NaCl$) or magnesium sulfate $MgSO_4$ or sodium hydrocarbonate ($NaHCO_3$) solution under specific conditions rinsed and dried, demonstrated a higher tolerance to salt, increased yields were reported from such seed planted in saline soils.[24]

Research is being conducted in many areas in an attempt to find more economical and more suitable methods of snow and ice removal. Caltrans as well as the highway users and the resources agencies would welcome a suitable substitute or an improved method that would be environmentally acceptable, economically feasible, and in adequate supply. Salt has caused considerable damage to the reinforcing steel in concrete bridge decks as well as to the metal parts in automobiles. Research should be continued on all fronts in the quest for better methods.

Essentially all pavement snow and ice control in the United States is performed by the long established method of plowing, sanding and salting. While there are numerous types of plows, snow blowers, and abrasives, the end technique for their use, the basic approaches remain the same. This is not surprising considering there has been no continuing program to provide for systematic research on new equipment, materials and techniques. Government funding has been scattered and insufficient; industry is not capable of supporting this type of research required to significantly advance the state of art.[30]

E. Air Quality

The quality of the air around us is affected by many things including pollutants emitted into it and the atmosphere's ability to disperse them.

The air quality in the Tahoe Basin is very good especially when compared with some other areas of the State.

There are various categories of pollutant sources, i.e., stationary, mobile and natural. In the analysis of the impact of placing salt on the roadway for snow removal the main concern is the effect it will have on the mobile source in respect to traffic volumes and speed of operation.

A study was made of the vehicle miles traveled (VMT) on an average winter day in the Tahoe Basin and an estimate was made of the vehicular operation if salt were no longer applied. These data were used to make estimates of vehicular emissions through 1995. The vehicle miles traveled, their average speeds and corresponding emissions in tons per day are shown in the following table.

These estimates are based on the time period of November to April which is the normal period when chain control is in effect.

Vehicular Data

Year	VMT With Salt	VMT Without Salt	SPEED With Salt	SPEED Without Salt	EMISSIONS WITH SALT CO	EMISSIONS WITH SALT RHC	EMISSIONS WITH SALT NOx	EMISSIONS WITHOUT SALT CO	EMISSIONS WITHOUT SALT RHC	EMISSIONS WITHOUT SALT NOx
1975	483,000	473,300	30	28	25.3	2.0	1.2	26.7	2.1	1.2
1976	502,530	463,700	30	28	22.2	1.8	1.2	22.0	1.7	1.0
1980	580,650	542,647	29	27	14.3	1.1	1.0	14.5	1.0	1.0
1985	678,300	641,331	28	26	9.5	0.7	0.8	9.4	0.7	0.8
1990	775,950	740,015	27	25	9.5	0.6	0.9	9.9	0.6	0.8
1995	873,600	838,700	27	25	10.7	0.7	1.0	11.2	0.7	0.9

VMT - Vehicle miles traveled per day.

CO - Carbon monoxide

RHC - Reactive hydrocarbons

NOx - Oxides of nitrogen

A pollutant of primary concern in the Basin is photochemical oxidant due to its potential damage to vegetation. The formation of oxidant is dependent upon the presence of reactive hydrocarbons, oxides of nitrogen and ultra violet light from the sun and the elevation of the Basin makes it the receptor of a greater than normal amount of the sun's rays.

It is the belief of some experts, any increase in oxidant concentrations above the natural background levels is damaging to some extent to the trees, however the forest is the source of some of the ingredients of oxidant due to the terpenes emitted by the trees and decaying material.

It appears there would be very little change in vehicular travel and resultant emissions whether salt is used for snow removal or not. The estimates show an approximate 4 percent reduction in vehicle miles traveled if salt were not used; however, the average speed of the traffic is reduced about 10 percent. This reduction in speed causes an increase in the hydrocarbon emissions per vehicle mile and as a result the total emissions per day remain approximately the same.

The impact should be even less if salt is used only in selected areas or spot locations.

F. Noise

Noise from snow removal equipment is variable in terms of human impact, depending upon storm intensity, duration, time of day, location, number of sensitive noise receptors adjacent to the highway, and type and amount of equipment that is pressed into the snow removal operation. Exposure to the noise from snow removal equipment is principally determined by the storm's intensity and duration and by the distance of the human receptors from the highway. Adverse noise impacts from the snow removal operation are generally greater at night and during times when reduced noise levels are desired.

Noise impacts are expected to be greater and of longer duration for snow removal operations which do not include the use of salt. The greater noise impact will occur because it is anticipated that the hours for chain control will increase by 1 to 3 days for each storm. This increase would cause a similar increase in the hours of exposure to noise from the operation of tire chains upon the motor vehicle. These changes are expected to be particularly noticeable in the South Lake Tahoe area in the four lane highway segments and where the largest concentrations of citizens live.

In addition to increased hours of exposure to chain generated noise within the basin, a no-salt maintenance program will increase the number of miles of highway which will require chain control.

On Route 50, more frequent chain control will be required over Echo Summit and into the basin, whereas a program using salt would often permit travel over Echo Summit without tire chains. A similar condition would exist on Route 267 over Brockway Summit and on Route 89 at Tahoe City.

The time for cleanup operations would be essentially independent of the type of highway maintenance program used during the snow season. The same kinds and numbers of equipment (sanders, plows, graders, and Sno-Gos) are anticipated for maintaining the highways. However, highway maintenance without the use of salt will require much more frequent sanding of the roadway which in turn will cause an increase in the frequency of occurrence of the operational noise.

The net noise impact upon persons residing in the Tahoe Basin and adjacent to the State highways is that they will experience an increase in hours of noise from tire chains and snow removal equipment if the use of salt for deicing is discontinued. This is not considered to be a significant impact.

G. Aesthetic Impact

Brown foliage or pale green needles on evergreen trees, other than that associated with normal annual die back is an aesthetically unpleasing experience in the eyes of most people who come to Tahoe to enjoy the natural scenery. An official, representing the interest of several businessmen, fears that the appearance of these effects might discourage visitors from coming to the area. Dead and dying trees and other vegetation have more of a visual impact in some areas than in others. Much depends on surroundings, proximity, background influence and certainly the ratio of affected to unaffected vegetation. It is reasonable to desire that the aesthetic pleasures afforded by this vegetative greenery be preserved and protected, especially in the vicinity of Lake Tahoe which is in itself an aesthetic attraction known worldwide.

If, in fact, the use of salt is responsible for damage to this vegetation, then mitigation measures must be explored. The current investigation being carried out by the University of California at Davis and Department of Transportation's Laboratory seeks to provide this information. As previously discussed, much evidence has been found that there are many reasons for vegetation decline. Root rot, needle blight, fungus, insect infestation, the possibility of ozone damage and change in micro-climate due to the highway corridor are all being investigated. Beyond this, greenhouse studies are being conducted to determine the salt-tolerance of various species which could be used for replacement of the less tolerant, providing salt is the main factor affecting the vegetation.

Some suggestion has been made that if salt, in the long term does in fact, cause certain species to die then that type of vegetation could be replaced with tolerant species within the area of influence. This would preserve the aesthetic integrity in keeping with the desirable objectives.

H. Economic and Growth Inducing Impacts

The effect of the use of salts to deice highways during winter storms has both short and long-term effects on the Tahoe Basin economy. Those portions of Placer and El Dorado Counties at Lake Tahoe receive practically all tourists and goods via the main State highways. Use of salt to deice highways allows truck, automobile and bus traffic to travel safely and efficiently when enroute to Lake Tahoe. The use of salt to deice the highways reduces the number of times that chains are required. When chains are not required for vehicles crossing through the main highway passes to Tahoe, then it can be said that: (1) total travel time is maintained at a level that is much faster and more efficient than when chains are required; (2) the cost and inconvenience of putting chains on are avoided; (3) the highway does not develop pot holes or unsafe icy conditions. The above facts are highly important to a tourist considering traveling to Lake Tahoe in the winter months. If the typical tourist realizes that a highway is being maintained to the point that much of the time during the winter he will not be required to use chains, he will be more inclined to travel to Tahoe to spend his leisure time. Tourists also consider that bare pavement provides travel conditions almost equal to that which he experiences during the summer months. These facts weigh heavy in a person's mind when deciding whether to enjoy his leisure-time activities at Lake Tahoe or elsewhere.

Besides the tourist, there are other groups of people who must travel to Lake Tahoe via the High Sierra highways; such as truck drivers who transport goods, businessmen who must travel to Tahoe for business purposes, and government employees who perform services in the Lake Tahoe Basin. Most of these people must travel to Tahoe no matter what the weather conditions or chain requirements are. A lack of need for chains because salt has deiced the roads means that people will save both time and money when traveling to Tahoe. This sector of the public has come to rely and depend on a normal number of chain-free days when traveling to Tahoe. Presently a truck driver hauling gasoline to South Lake Tahoe can usually estimate whether or not he will have to chain up by checking predicted weather conditions for the High Sierras. In the same manner, a businessman can determine his time of arrival in South Lake Tahoe and keep his appointment by simply knowing the weather.

Most businesses and industries in the Tahoe Basin estimate their winter business by previous years' business experience. Their experience is based on the number of tourists who came to Tahoe in previous winters. The continued use of salt to deice highways will not cause a change in the visitor-day trends that have been useful to these businessmen. Estimating their volume of business enables businessmen to determine inventory needs, the number of employees they must employ in the winter, and how much equipment they must provide. Motels and hotels are able to estimate how many maids they must employ, casinos can estimate how many card dealers they must have on hand, and ski resorts can estimate how many ski lift operators will be needed. Thus, direct impact of the use of salt to deice highways in the Tahoe Basin will be to maintain the economy at its present level and growth rate in the short run.

Whether or not salt is used for deicing highways during the winter, the economic growth at Lake Tahoe is expected to continue at about the same rate. Other controls such as zoning, land capability limitations, and possible transportation corridor restrictions would tend to have a much greater influence on growth in the Basin. Use of salt is not considered to have a significant growth inducing impact on the Basin.

If the continued use of salt for deicing should have an adverse effect on the natural environment by affecting vegetation within 50 feet of the highway or by affecting the water quality of streams or the Lake, then there might be an accompanying long-term effect on the economy. However, it is considered that the maximum effect due to this possibility would be relatively minor in respect to other major factors which have generated the present economy.

An additional impact of the use of salt on highways is the damage caused to automobiles by salt corrosion. It is estimated by the Society of Automotive Engineers that body corrosion costs to motorists run about $100 per year, in which perhaps 50%, according to the American Public Works Association, can be directly attributed to deicing salts.[31] These figures represent the nationwide averages and should only be used as an example of what corrosion costs could be. This, however, might be mitigated by having car washes at strategic locations.

Another unusual problem caused by the use of salt on highways is the potential for the contamination of drinking water. This problem is experienced mainly in Eastern States and is usually associated with hand dug wells or wells that have not been put very deep into the soil and are located reasonably close to the highway. It is expected that problems of this type would have been discovered already in the Tahoe Basin through the past use of salt on highways if such problems are possible. The usual remedy for these situations is to replace the existing wells with much deeper wells that go into water strata that have not been contaminated by salt.

I. Social Impacts

The social impacts of using salt to deice California highways in the Tahoe Basin would be to sustain those social trends that are explained in the Environmental Setting of this report. In order to provide a better description of the impacts of salt usage, a comparison of the impacts resulting from a no salt policy follows.

Social impacts associated with cessation of the salting program occupy four categories:

1) Impacts on residents of the Lake Tahoe Basin;
2) Impacts on the provision of public services;
3) Impacts on visitors arriving there from outside the Basin; and
4) Impacts on the transportation of goods into the Basin.

On February 19, 1975, telephone interviews were conducted from Sacramento with Basin area private business spokesmen, law enforcement officials, public service personnel, and the owners of retail outlets.[35] After a brief opening introduction, questioning continued on each of the categories above, as follows:

1) Residents. Automobile distributors and dealers, gasoline-retail outlets, and various law-enforcement authorities were contacted to determine whether an end to the salting program would effect their designated activities in any way. (This question was stated as an open-ended query, favoring neither a yes or no response.) A suggestion was also raised that local residents along unsalted roads and streets might now be inconvenienced by their having to remove tire chains before venturing onto bare State pavements.

2) Public Services. Contacted were area post offices, taxi companies, ambulance services, law enforcement authorities, public school bus drivers and mechanics. Those contacted were asking how and to what extent non-salting would effect their particular activities. Again, an open-ended assumption was made. All those queried spent a sizeable portion of their in-car time on salted State highways.

3) Visitors. Bus operators, law-enforcement authorities and gasoline retail outlets were queried in regard to changes in the frequency of visits by persons from outside the Basin.

4. Freight Companies. Numerous trucking firms in the Sacramento and Lake Tahoe area were asked whether or not their services into and out of the Basin (if any) would be affected.

All of those queried replied that they used State roads frequently. Findings generated by these interviews are included under various headings, below.

1. Land Use and Land Tenure. A review of secondary evidence reveals predominantly resort-oriented patterns of land-use and tenure. Summer uses are, of course, not affected. Exclusively winter-dependent uses, such as skiing slopes, are visited by drivers undaunted by almost the entire range of cold-weather conditions, according to various law-enforcement authorities.

2. Transportation and Circulation. Generally, the impacts of non-salting will be greater here than on land use and tenure, above. Law-enforcement officials were especially quick to note that vehicular accidents would increase markedly were salting to be stopped, especially at intersections. Major South Lake Tahoe intersections on Highway 50 include Park Avenue, Pioneer Trail, Ski Run Boulevard, Rufus Allen Boulevard, Lakeview Avenue, Al Tahoe Boulevard, Tahoe Keys Boulevard, and the Highway 89 and Highway 50 intersection at Mays. Non-salting would also slow mail deliveries, especially when tight delivery schedules are required. Although ambulance operators did not foresee too great an impact, bus drivers feared a reduced degree of control over their vehicles. One area taxicab company emphasized that rapid melting-freezing cycles locally dictate remedial salting programs, as at present. Without salting, airport-limousine vehicles would require use of chains, inconveniencing and even curtailing services when roads and streets are icy.

At least one major automobile dealer in the Basin maintained that of automobiles adversely affected by icy road conditions, smaller ones would be impacted more greatly, at least on steeper grades. Conversely, the control characteristics of larger cars on level surfaces would be more greatly affected. It should be emphasized, however, that today's marketing trends favor smaller vehicles. Again, one repair shop noticed that new accident repair business originates more frequently from accidents on icy roads.

3. Sociology. There have been comments to the effect that local residents need to either remove chains or drive on bare pavement with chains after needing them to drive on side roads or driveways. A majority of residents, however, do not presently feel inconvenienced by this necessity. Many local residents have equipped their vehicles with studded snow tires. However after May 1, 1975, the present law does not allow the use of tire studs unless pending legislation extends this provision.

Impassable roads would greatly complicate law-enforcement were deicing halted. While mail deliveries would not necessarily be curtailed, these would nevertheless be delayed, a situation complicated by contract requirements and tight delivery schedules. Besides ambulance services being hampered to some degree, operators also pointed out the harm salt has inflicted on their vehicles in the past. School bus operators indicated that their vehicles would be more dangerous to operate on unsalted road surfaces, apart from delays. Some law-enforcement officials feared that icy-road surfaces would hamper their deterrent capabilities.

Although bus drivers anticipated little difficulty as a result of poor road conditions, some private automobile operators are "scared to death" of ice, according to one gasoline station operator. With the possible exception of skiers, visitors from outside the Basin put off their trips until roads are clear. As much as a 25%-30% drop in volume occurs on weekdays after major storms. "Fender-bangers" and pileups occur when drivers, accustomed to dry pavements, venture incautiously onto slick or icy surfaces. Another dealer warned that visiting levels may generally drop off after the "word" gets around that salting programs have ceased.

J. Public Service

1. Safety

The "bare pavement" policy was established on the premise that both safety and convenience were provided in greater degree to the highway user who pays taxes for this service. The use of salt along with abrasives such as sand and cinders has helped to effect this bare pavement condition more of the time when it would otherwise be covered with a pack of snow. In recent years there has been doubt cast on whether the use of salt does in fact provide a safer condition. One publication presents the view that a brine solution causes a more slippery surface than would exist without the use of salt.[33]

Others point out that the effectiveness of deicing salts in maintaining highway safety is questionable.[7]

Other sources of information would tend to indicate that the discontinuation of the use of salt cannot be tolerated due to the hazardous conditions that result.

In 1972 the town of Concord, Massachusetts lifted its no-salt ban in midwinter after experiencing a 30 percent increase in accidents.[34]

The State Legislature in Wisconsin turned down a proposal to establish legal limits on use of salt for deicing.[35]

The cases cited above both pro and con were in eastern climatic conditions which differ somewhat from those found in the Tahoe Region. Severity of storms, amount of snowfall, freeze-thaw due to temperature variation and water content of the snow are a few of the conditions which may vary. Methods of application and quantities used are also different in some of the eastern practices. For example, it is the exception rather than the rule when pure salt is applied rather than a mixture of salt and abrasives in the Tahoe Region. Many eastern states use only pure salt for reasons of cost of cleanup or the theory that pure salt is more efficient. In any case these differences make the evidence less applicable when considering the western high elevation condition in the Tahoe region.

A comparison of accident history for the winter of 1973-74 was made on Route 50 in El Dorado County between Riverton and Meyers. This section was chosen because it serves as the main connection to the most populous south area of the Basin from the Sacramento Valley and San Francisco Bay areas. It is the one which would affect the greater number of persons in winter driving if there were a change in level of service. The alignment is about the same over the entire 31 miles of this two-lane mountain highway. (May be driven comfortably at 40 to 50 mph on dry pavement with some exceptions.) The comparison was made using times when chain controls were in effect at the higher elevations due to snow and ice and when a wet pavement condition existed at the lower elevations. The results indicate a 4:1 ratio of accidents per hour-mile occurring within the chain control area versus the wet pavement area. The ratio was developed by multiplying hours of chain control by miles of road for each condition. A further breakdown indicates that injury type accidents predominated 12 to 1 within the chain control area compared to outside and about 3 "property damage only" type accidents for every one outside. There were no fatal accidents during the period of the study.

Another study by Caltrans for the 1973-74 winter compared the winter time accident rate (November through April) with the summer time rate. This investigation entitled "Bare Pavement Snow Removal Policy"[36] showed a 5½ times greater accident rate in winter. This study covered the same 31 mile section of Route 50 in El Dorado County.

In January 1973, "The American City" magazine, a major supporter of the Salt Institute's stand, published the results of a survey of 116 cities in 20 northern states. According to the article, the survey indicated that four times as many vehicular accidents occur in streets untreated by deicing salts as on those treated with salt.

None of these studies can be considered conclusive. They are at best, only indications of what might be expected with any change policy.

Comments solicited from the California Highway Patrol at South Lake Tahoe indicate a strong feeling in support of the continued use of salt for safety. Their memorandum states in part:

"The use of ice reducing compounds on the roadway in this geographical area are essential in our traffic accident prevention efforts. Minimizing salt accumulation by the most practical effective compound is one of the basic steps in winter driving safety."[37]

This viewpoint is supported by highway maintenance personnel who have had years of experience in the field where the problems of snow removal, traffic movement and traffic safety are dealt with under the most severe conditions. Some of these people have worked in snow removal without salt in past years and continue to favor its use.

Emergency vehicles are vitally dependent on their ability to reach destinations as quickly as possible. Any reduction in the level of service now being provided would have to be weighed carefully in terms of life and property damage that might be affected. Studded tires have been allowed in California between October 1 and May 1 since 1969, but will no longer be allowed after May 1, 1975 unless provision is made by law to allow their use to continue.

The discussion of safety and accidents cannot be complete without considering litigation. Rulings in many cases have held government liable for accidents caused by adverse roadway conditions if the responsible officials were aware of those conditions and if it was feasible to correct the condition.

David C. Oliver, Attorney Advisor, of the Federal Highway Administration sums up the assumption of liability by government in its proprietary (housekeeping) functions.

"Anticipation and negligence are the watchwords in inspection and enforcement where slippery conditions are present. Regular patrols, evidence of salting and sanding policies and like evidence normally meet the burden of anticipation. Negligence which is the proximate cause of the accident is necessary to show a failure to meet this burden on the part of the government."[44]

In a paper prepared by the Assistant Chief Counsel for California's Department of Transportation Legal Division, Robert F. Carlson makes the following statement.

"When dealing with the skid-resistant qualities of road surfaces one of the most salient legal considerations is the potential liability arising from an automobile accident caused to some degree by the surface of the pavement. Although some accidents may be caused by low skid-resistant pavement under dry conditions, by far, the majority of slippery pavement related accidents occur during inclement weather. Of course, when snow and ice form on the pavement it is inevitable that accidents will ensue. These accidents, however, are less related to the skid resistance of the pavement itself than to the efficiency of highway crews in ameliorating the hazards by use of sand or chemicals. It is primarily under non-freezing, wet weather conditions that the skid resistance of the pavement itself, whether by design or by maintenance, may be a deciding factor in determining whether or not a potential accident, in fact, occurs. For this reason, coupled with what has been in recent times a duty on the part of public entities to provide up-to-date skid-resistant highways, many lawsuits are now being initiated as a result of what used to be considered purely weather caused accidents."[6]

The general statutory authority under which Transportation deices roads as a part of its road maintenance operations, is contained in Section 91 of the Streets and Highways Code, which provides that:

"The department shall improve and maintain the State highways, including all traversable highways which have been adopted or designated as State highways by the Commission, as provided in this code."

"(c) The special or emergency maintenance or repair necessitated by accidents or by storms or other weather conditions, slides, settlements or other unusual or unexpected damage to a roadway, structure or facility."

"The degree and type of maintenance for each highway, or portion thereof, shall be determined in the discretion of the authorities charged with the maintenance thereof, taking into consideration traffic requirements and moneys available therefor."

Legal counsel has warned against significantly lowering levels of service without evaluating results from four or five years of pilot studies.[36]

2. Convenience

Convenience can best be evaluated by experiencing the need to put chains on a vehicle or to pay the price of installation (currently about $5.00 for putting on and $3.00 for taking off). One can scarcely appreciate the task without personally subjected to it. Conditions are at their worst both in wetness and coldness. The time taken to accomplish the feat as well as the reduced speed allowable with chains are considered an inconvenience by most travellers and especially those who are inexperienced.

Even with the most efficient manner in which snow removal operations are presently practiced, letters of complaint are received. It might be logical to predict that these would increase in volume at least in proportion to the increased length of time chain controls were in effect without the use of salt.

Based on a two-year study it is estimated that chain controls are in effect for 500 to 600 hours per year in the Tahoe Basin. The increase with a no-salt policy is estimated to be 1 to 3 days longer per major storm. This would result in at least a 50% increase in chain control time.

K. Energy Consumption

Fuel consumption tests made near Ogdensburg, New York, in 1970 and 1971 were presented in a paper[38] by Paul Claffey at the Highway Research Board Convention in 1971.

The results of these tests indicated that fuel consumption for passenger cars increased over the consumption required on dry pavement due to the irregular surface of potholes, ruts and the washboard-like surface that occurs on packed ice and snow when vehicles are driven on it and when new-fallen snow in depths of one-half inch or more are allowed to accumulate. The irregular surface causes vehicles to use more fuel because the wheels of the vehicles must climb over these irregularities. Greater effort (and more fuel consumption) is required on fresh-fallen snow because the wheels have to pack the snow down and climb over and across ruts left by other vehicles. Slipperiness, in itself, does not increase fuel consumption substantially because drivers tend to use more caution and hold wheel slippage of their vehicles to a minimum.

The tests were run on a straight and level section of good paved road with running speeds of 20, 30, 40, 50 and 60 miles per hour (except where new-fallen snow exceeded one-half inch) and for stop-and-go driving with running speeds of 30 to 50 m.p.h. These tests were performed under a variety of ice and snow surface conditions and fuel consumption compared to the fuel consumption required for dry-pavement driving at the same speeds. The following figures 7 and 8 graphically illustrate the impact that ice and snow conditions have on the fuel consumption of passenger cars.[38]

As the curves indicate, there is a significant increase in fuel consumption for ice and snow conditions with the severest occurring when there is newly fallen snow.

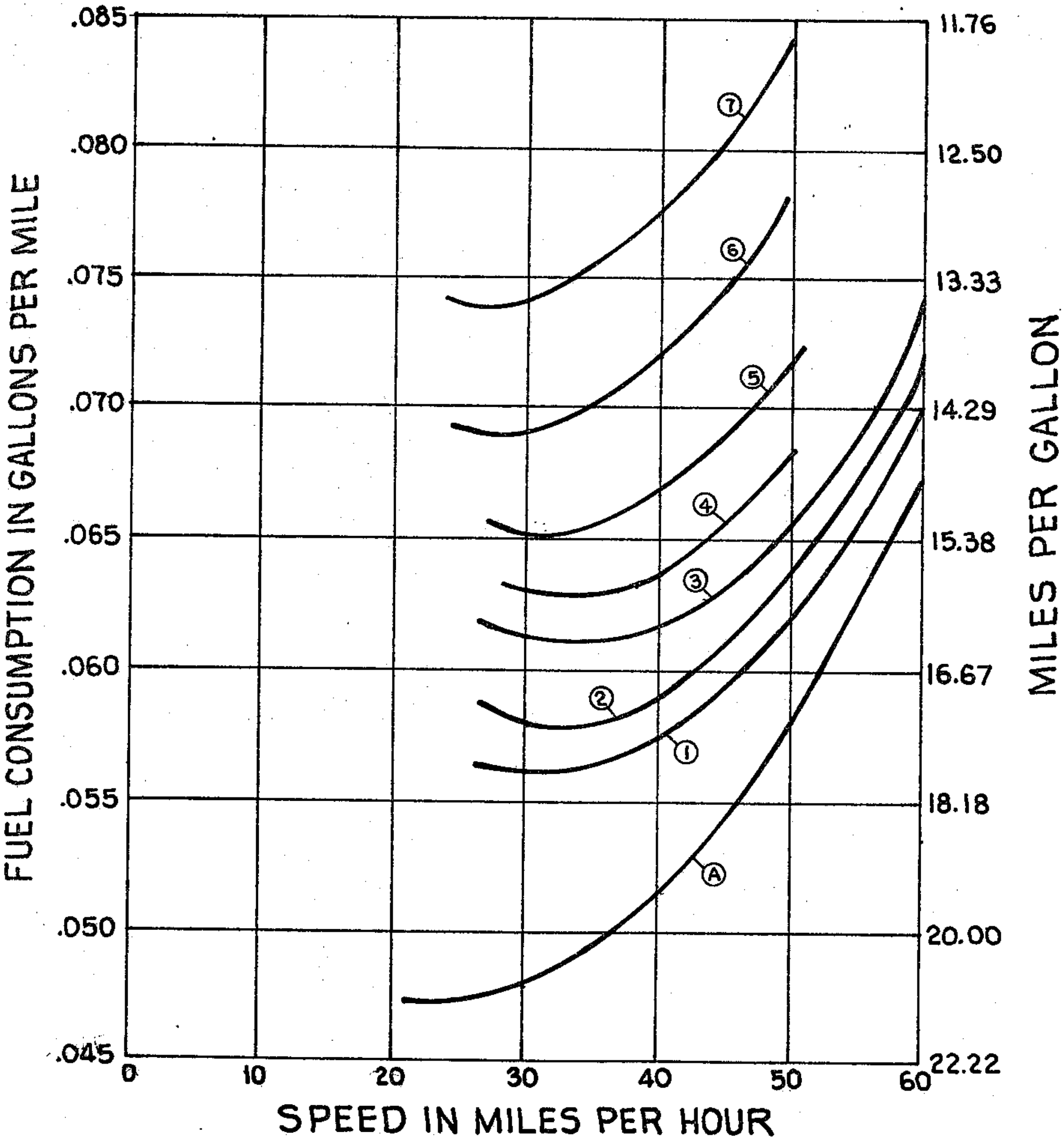
There are six sections of California State highway within the Tahoe Basin which are frequently subjected to chain controls during the winter season.

These sections are:

Route 28, Tahoe City to the Nevada State Line;
Route 267, from Kings Beach toward Truckee;
Route 89, from Tahoe City toward Interstate Route 80;
Route 89, north of Route 50, and along the west shore of Lake Tahoe;
Route 89, south of Route 50 to Alpine County;
Route 50, from Meyers toward Echo Summit.

FIGURE 7

FUEL CONSUMPTION RATES OF A PASSENGER CAR FOR VARIOUS ICE AND SNOW CONDITIONS



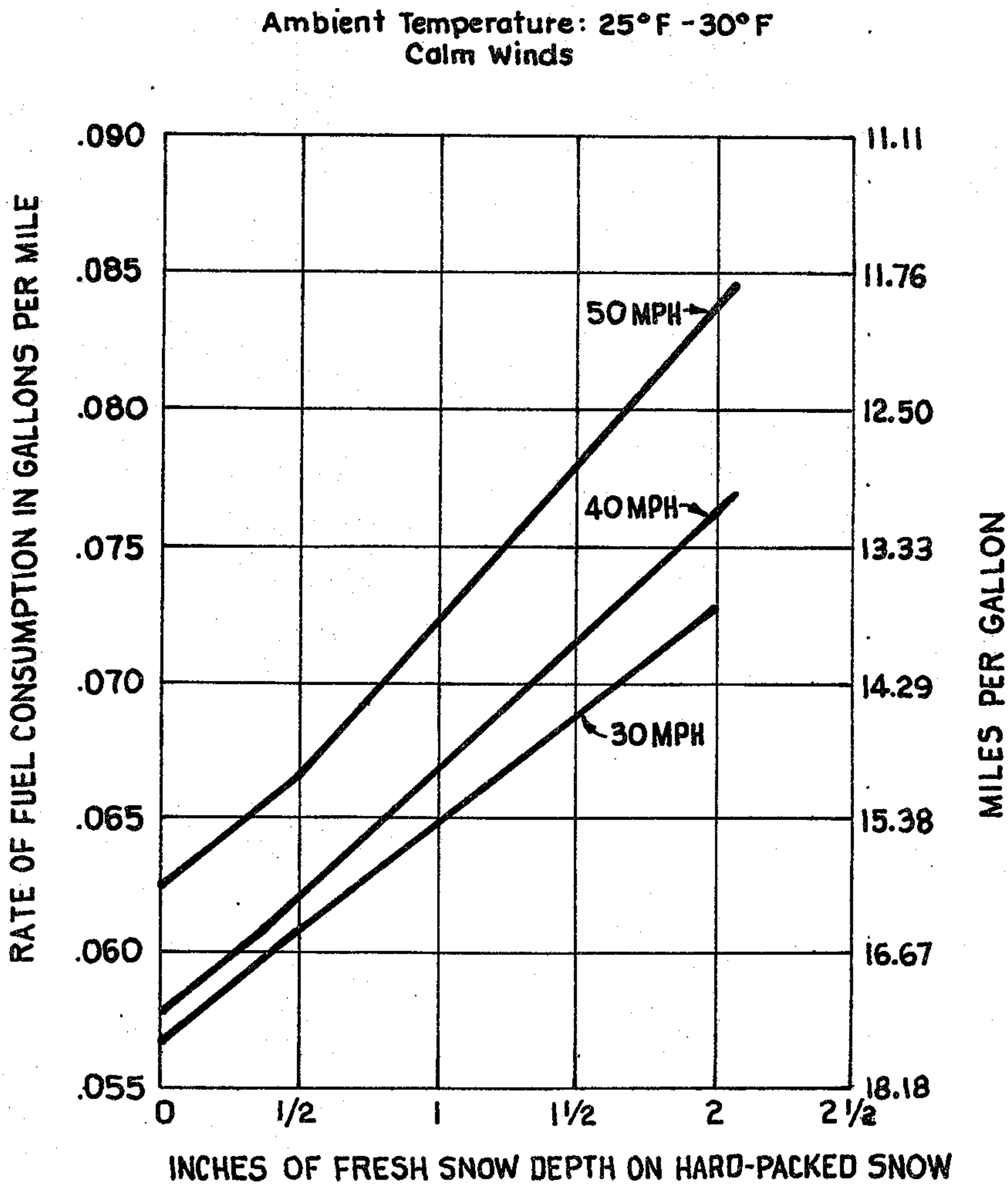
ICE AND SNOW CONDITIONS (25°F-30°F)

Ⓐ Dry Pavement
① Very slippery hard-packed snow and ice.
② Hard-packed snow on ice with irregular bumpy wrinkled surface.
③ ½ inch new snow on hard-packed snow.
④ ¾ inch new snow on hard-packed snow.
⑤ 1 inch new snow on hard-packed snow.
⑥ 1½ inch new snow on hard-packed snow.
⑦ 2 inches new snow on hard-packed snow.

Source: Highway Research Record #383, Washington, D.C.

FIGURE 8

RELATIONSHIP BETWEEN SNOW DEPTH AND RATE OF FUEL CONSUMPTION OF PASSENGER CARS



Source: Highway Research Record #383
Washington, D.C.

The annual average time that chain control is in effect on these sections, based on the 1972-73 season and the 1973-74 season, has been estimated by Caltrans as follows:

Route	Annual Average No. of Hours
28	430
267	450
89 (Tahoe City toward I-80)	420
89 (South of Route 50)	750
89 (North of Route 50)	460
50	600

It has also been estimated that without the use of deicing salt, chain control conditions would prevail from 1 to 3 days longer per storm.

Maintenance equipment assigned and used by District 03 of the California Department of Transportation during average snow storms on the State highway routes within the Tahoe Basin consist of: six sanders, ten snow plow trucks, eight motor graders, and seven Sno-Gos.

In addition to using equipment during times chain controls are in effect, sanding and salting operations are frequently employed before and after chain control conditions.

It has been estimated by Caltrans that if deicing salts were not used, the above equipment would be required to operate approximately 50 percent more time. This would be an additional impact on energy consumption associated with maintaining the State highways.

ADVERSE ENVIRONMENTAL EFFECTS

IV.

ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED IF THE PROPOSED ACTION IS IMPLEMENTED

This study concerns the use of salt for deicing State highways in the Tahoe Basin. At this point it can only be assumed that if salt in responsible for the described damage to vegetation that this would be an effect which could not be avoided. If this were the case then there would be a gradual removal of affected vegetation within the 50 foot corridor alongside the roadway. Trees would die and be removed and it would be a matter of considering as time goes on whether to leave this corridor open or whether to revegetate it with salt tolerant species.

If, on the other hand, it is found that salt is not responsible for all the damage then the environmental effects would not have any relationship to the use of this chemical. Hopefully, at the conclusion of the ongoing study on vegetation, there will be answers not only to those questions posed above but to the questions; what is causing the trees to die, and what can be suggested as an alternate to prevent this from happening.

The same reasoning would apply to the possible adverse effects on aquatic biota and water quality. Further action in this regard is also dependent on the ongoing study results.

The impact on aesthetics is probably the greatest consideration with regard to dying and dead trees along the highway. Cutting them down removes them from sight. Then it is a matter of deciding whether they should be replaced, or whether this corridor would look unnatural and be aesthetically unpleasing to the viewer.

ALTERNATIVES ➡

V.

ALTERNATIVES

A. Alternate 1

Modify present practices by restricting use of salt to specific locations for safety; such as intersections, curves, shaded areas and steep grades. Continue snow removal operations and use of abrasives in greater quantities at remaining locations. This alternative would have the effect of returning the highway system in the basin to a condition which existed about 20 years ago. The practices of salting at specific locations was practiced at that time. There was not nearly the amount of traffic in the winter time then as there is now. Motorists had not been provided with the level of service which is now in effect and were generally tuned to the practice of putting chains on and driving slower or foregoing the privilege of traveling over some of these routes. There would be a potential hazard in building a sense of security into the driver while he traversed the locations where salt is used. He might then find himself on a low traction surface too late to react to the situation. If this alternate were adopted at this time it would be imperative that much publicity be given in advance of the winter season.

The additional cost of the operation of equipment would be significant and there would be a large increase in the use of abrasives such as sand and cinders. The impact from this would be noted mainly in the cost cleanup in the built-up areas, in the aesthetic impact on the roadside and in the depletion of the supply of sand and cinders. There would be some minor effect from the increased use of abrasives on siltation of the streams and the lake. The specifications on abrasives limit the amount of fines to less than 5% for sand and 9% for cinders, therefore, this impact would be minor compared to what is tracked onto the highway from unpaved side roads and driveways.[48,57] Probably the largest adverse impact from this first alternate would be the inconvenience experienced by the driver who is now expecting a relatively high level of service for his winter-time driving. It could be expected that there would be an increase in correspondence in the way of complaints from these people.

This program would remain in effect until studies on the environmental effect of the use of salt are completed. Under this proposed alternative, it is expected that the total amount of salt used on State highways in the Basin would be reduced by about ¼, however, the increased cost of the use of equipment and the increased cost for abrasives would more than offset this savings. The net effect would be an increase in the average annual cost of about $55,000 over the present amount of $475,000 for snow removal operations in the Tahoe Basin.

B. Alternate 2

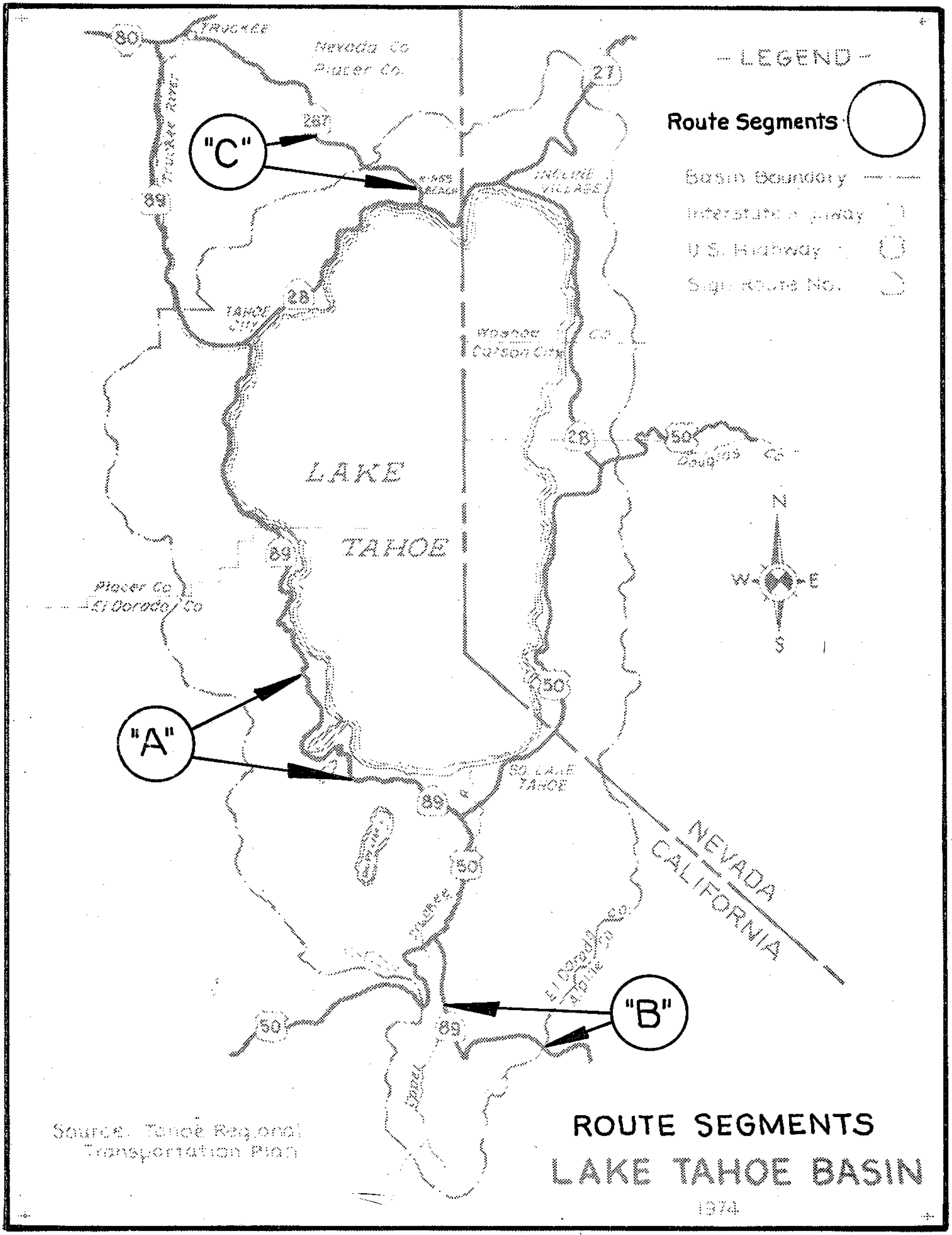
Select segments of certain routes where vegetation damage has a greater impact due to the aesthetic effect and curtail or omit use of salt in those areas. (See Figure 9 - Route Segments - next page) To allow the highway around Emerald Bay (Segment A) to close in the winter would probably have the least impact on the traveling public. This section of Route 89 between Cascade Stables and Bliss State Park serves very few local residents. It is used in the wintertime mainly for commute and deliveries between the Tahoe City area and the South Lake Tahoe area. If it were closed, commuters would be forced to go around the other side of the lake through Nevada State, a distance of about 16 miles longer. The closing would result in a cost savings with regard to the use of maintenance equipment and the cost of salt and abrasives. The net savings in costs cannot be determined without first deciding on the time or condition required for the spring opening. Any savings in cost of materials and operation would be at least partly reduced by the spring opening especially if a late snow storm necessitated the repeat performance of opening later in the spring. The main consideration for this alternate would be cost and inconvenience to the highway user.

If other routes or sections of routes were allowed to close in this manner, it would have an even greater impact on the highway user and on present traffic patterns. As an example, if Luther Pass (Segment B on map) were not kept open during the winter it would curtail the travel and services between South Lake Tahoe and Kirkwood Meadows ski area on Route 88 as well as to points south, on Highway 89 in Alpine County, such as Markleeville. Another example would be Route 267 over Brockway Summit (Segment C). Closing this route segment would have an impact on anyone traveling between Truckee and North Shore or Kings Beach area, and on emergency service to the hospital in Truckee. They would have to go by way of Tahoe City on Routes 28 and 89, about 12 miles further. The congestion of traffic on weekends would be intolerable, especially in the Tahoe City area.

C. Alternate 3

To continue searching for other acceptable deicing chemicals. This is being done not only for environmental reasons, but also due to the effect of salt on bridge decks and automotive hardware. It would not be feasible to stop using sodium

FIGURE 9



- LEGEND -
Route Segments
Basin Boundary
U.S. Highway
80
Truckee
Nevada Co
Placer Co.
267
27
"C"
Incline Village
89
28
Tahoe City
Washoe Co.
Carson City
LAKE
TAHOE
50
Douglas Co.
N
W
E
S
Placer Co
El Dorado Co
"A"
So. Lake Tahoe
NEVADA
CALIFORNIA
El Dorado Co.
Alpine Co.
"B"
Source: Tahoe Regional Transportation Plan
ROUTE SEGMENTS
LAKE TAHOE BASIN
1974

chloride until a satisfactory alternative chemical is found. There is no way of knowing how long this might take. The impact of using any of the chemicals so far tested might prove to be both environmentally damaging and economically prohibitive.

The EPA states in their publication titled, "Environmental Impact of Highway Deicing"[39] that, in using highway deicers it is not necessary to melt more than 10% of the ice cover. Vehicular traffic will normally melt the remaining snow and ice quickly and efficiently.

Corrosion of steel and associated distress in concrete decks which were salted to control ice and snow prompted a search for a non-corrosive deicing chemical which would compete in cost and in effectiveness with the chloride type deicers currently in use. 17 deicing chemicals were compared on the basis of:

1. Their effectiveness in melting ice, frost and snow,
2. Their effectiveness in preventing frost or icing,
3. Their effect on construction materials such as concrete and steel,
4. Their effect on the ecology, and toxicity to humans,
5. Their effectiveness on skid resistance.

While a variety of tests were performed, not all tests were performed on each chemical. Ice melting tests were very useful in laboratory evaluations but lab performance is not necessarily representative of what may occur in the field.

One chemical investigated, tetra-potassium pyrophosphate (TKPP), appeared to have good holding power, in that it was able to prevent the reoccurrence of frost for a comparitively long time. Since TKPP performed relatively well in the corrosivity to steel and concrete test and imposed no specific problem regarding toxicity, it was selected for field skid testing as well. The concentration of a 30% solution caused a temporary reduction in skid resistance as did the solution of calcium chloride. But the simultaneous addition of sand should keep skid resistance at an acceptable level at all times.[40]

Current studies by Dr. Charles Goldman of Ecological Research Associates include bioassays, performed on present deicing materials, (NaCl), and on 12 other possible alternative compounds including formamide urea, sodium benzoate, calcium formate, sodium formate, magnesium sulfate, sodium acetate, sodium sulfate, magnesium chloride, ethylene glycol, sodium metasilicate, tetrapotassium pyrophosphate, and tripotassium phosphate.

The EPA publication entitled, "A Search"[41] states the belief that the reduction of ice adhesion by use of hydrophobic (water repelling) substances poses the greatest opportunity for significantly advancing the art of ice and snow removal. The substance required must be capable of being applied to existing roads, be long lasting, have a negligible effect on traction, and be reasonably priced. A specific substance which can fill all these requirements has not yet been identified.

D. Alternate 4 (Do nothing)

The do nothing alternative would mean eliminating the use of salt within the Basin but continue snow removal operations and use of abrasives (sand and cinders) in greater quantities to maintain safe travel. This alternative would have the greatest impact on the traveling public. It would mean use of chains from one to three days longer after each storm. (There are an average of 10 to 20 storms per winter.) It would mean road closures which do not now exist. It would probably mean an increase in accidents and it would mean an increased use of abrasives with accompanying impacts.

Reduction in cost due to elimination of salt would be about $30,000. Increased cost of operation and use of abrasives would be about $238,000 based on a 50% increase. Net additional costs would be $208,000 plus costs incurred by the highway users.

Implementation of any of these alternates should be delayed until present studies are completed. The assumption that the vegetation damage and other environmental impacts would be eliminated by any of these alternates has yet to be determined.

VI.

CUMULATIVE AND LONG TERM EFFECT OF ACTION

The coniferous trees that were the center of attention for the U.S.F.S. study[32] are reported to be sensitive to salt as compared to other woody plants. At the present levels that sodium chloride is used, whatever damage that might be resulting from salting would certainly continue. The conclusions reached as a result of ongoing research will define whether the damage is sodium accumulation in the soil, salt buildup in plant tissues from root uptake or foliar assimilation, from mechanical abrasion or some other source.

In the event that salt is destroying vegetation the stands will become less dense in the highway corridor in the next few years, because the short growing season and infertive soils make revegetation difficult. This would allow an increase in erosion and sedimentation if revegetation were not effective.

The sodium in highway deicing salts has the capability to bind together heavy clay particles in some soils which reduces the natural permeability. The low ion exchange capacity of the granitic soils in the Tahoe basin may not exhibit this characteristic.

The primary long term effect on water quality might be the buildup of the chloride concentration in the lake itself. At the present time this buildup is considered negligible because with the average application of 1460 tons per year for the next 50 years and if all of it ended up in the lake and were retained, the increase in sodium chloride concentration would be 0.44 parts per million, a small increase in the present average level of 2.6.

If it is ultimately shown that salt has a negative effect on the Lake Tahoe environment, then the accumulative and long term effect of using salt on California highways would create a slight reduction in rate of increase of the economy. This would be caused by a decrease in tourists coming to the Tahoe Basin. The range of beneficial uses of this region will be affected. A reduction in the beauty of the Tahoe region would curtail the rate of increase in the number of sightseers visiting tthis area. Any reduction in the beauty of the Tahoe area would reduce the benefits of this region to our society.

VII.

IRREVERSIBLE ENVIRONMENTAL CHANGES

A. Uses of Non-Renewable Resources

1. Sand

Sand used on highways is one resource that could be considered non-renewable. In the past, and as far as can be predicted, it is not economical to attempt to reclaim sand that has been applied to highways, due to the costs of sweeping, vacuuming, hauling, grading, and washing.

Caltrans' records show that in the Tahoe Basin during the 1972-73 season 11,832 tons of sand were used and 440 tons of cinders (total 12,272 tons). In the 1973-74 season 6,947 tons of sand and 4,548 tons of cinders were used (total 11,495 tons). The sand supply is limited while, at this time, the cinder supply is not. If the use of salt for deicing were not allowed, the increase in the use of sand and cinders would be between 30 and 100 percent depending on the particular location and such considerations as snowfall, temperatures, and traffic conditions.

2. Fuel

If the use of salt were discontinued, additional fuel would be required for vehicles traveling on ice and snow surfaces and for increased use of maintenance equipment to keep highways passable. This increase in fuel has been discussed in Section III, Environmental Impacts and Mitigation Measures - Energy Consumption.

VIII.

COORDINATION

The development of the proposed project has been coordinated with various Federal, State and local agencies. Agencies and organizations that have been contacted are:

James Bruner Executive Director	League to Save Lake Tahoe
Greg Hansen Professional Engineer	Tahoe Regional Planning Agencies
Harry Siebert	U. S. Forest Service
Dave Dubois Professional Engineer	Lahontan Regional Water Quality Control Board
Dr. Michael Srago Plant Pathologist	U. S. Forest Service
Dr. John Maxfield Plant Pathologist	University of Nevada at Reno
Preston Wilson	Nevada State Highway Department
Michael Foley Executive Officer	California Tahoe Regional Planning Agency
Captain Harry Adair Area Commander	California Highway Patrol
Lt. John Sherman	California Highway Patrol
Dr. Andrew Leiser Environmental Horticulturist	University of California at Davis
Art Cort Director of Public Works	County of El Dorado
Dr. Wayne Williams Plant Pathologist	U. S. Forest Service
Ed Stollery, Editor	Tahoe World Newspaper Tahoe City

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